



UNIVERSITY OF  
LIVERPOOL

**Exploring Postgraduate Development to  
Demonstrate Competency During Endodontist  
Specialist Training at the University of Liverpool  
Dental Hospital**

**By**

**Abdulwahab Alansari**

Supervised by

Professor Luke Dawson  
Professor Fadi Jarad  
Dr Charles Buckley

*Thesis submitted to the  
University of Liverpool  
in partial fulfilment of the requirements for the  
Degree of Doctor of Dental Science in Endodontics*

**March 2018**

# Abstract

## Title

Exploring Postgraduate Development to Demonstrate Competency During Endodontic Specialist Training at the University of Liverpool

## Introduction

The General Dental Council (GDC) prescribes the intended learning outcomes for endodontic specialist training in the UK. The GDC also requires all dental professionals to be lifelong learners. The purpose of this study was to investigate current approaches to developing a specialist endodontist that is fit for purpose and fulfils all aspects of the GDC requirements.

## Aims

- Identify the GDC's endodontic intended learning outcomes (ILO's) related to undergraduate (UG) and postgraduate (PG) training to establish the baseline level of knowledge and skill expected for postgraduate training
- Gain insight into the perceptions and opinions of current endodontist specialist trainees over their current training and its educational impact.
- Use the information gained to inform future best practice in endodontic training

## Methods

Three independent, but related, projects were undertaken to achieve the aims. The first project was a mapping exercise of the PG curriculum against the UG curriculum to establish the expected level of knowledge and experience gained from undergraduate training. In addition, this mapping exercise would also highlight what knowledge and skills need to be emphasised during specialist training. Postgraduate ILO's were used as the map's main framework. Similar ILO's in the undergraduate curriculum were highlighted. Linear alignment took place of similar ILOs from each curriculum and the map of aligned endodontic skills was completed.

The second project was a survey of the current teaching and assessment modalities used by Dental schools (located in England and Wales) in order to gain insight into the potential variation in capability of people entering into specialist endodontic training. Permission was gained to continue the ADEE Survey which explores a range of issues associated with the teaching and assessment approaches used in undergraduate endodontic education. The survey was digitally hosted, and the data was transferred to a secure Microsoft Excel spreadsheet for analysis.

The final project was a series of structured interviews to gain insight into the perceptions and opinions of postgraduates on the programme of study. The syntax gained from this format of investigation could provide further data to enable identifying any shortfalls and inform future best practice. Following ethical approval, a schedule was constructed. Postgraduates were recruited and consented. All interviews were audio recorded and transcribed verbatim. Thematic analysis (1) took place. Themes and codes were refined and documented.

## Results:

The mapping project identified four main commonalities between UG and PG endodontic curricula – they were identified as the ‘Golden Pillars’ in current endodontic practice. These included the ability to assess, examine a patient; reaching a definitive endodontic diagnosis; awareness of current research and an evidence-based approach treatment provision; treat all colleagues and patients with honesty and respect.

The survey project demonstrated major differences in the amount of endodontic clinical experience gained in UG training, as well as the type of teaching and assessment methods. The variation is significant between each school, and can even differ between students in the same Dental school.

Data gained from the interviews, and subsequent thematic analysis, resulted in four main themes to emerge. Theme 1 was the postgraduates’ perception towards having a structured speciality training curriculum, Theme 2 was the postgraduates’ perception towards their speciality training, Theme 3 was the postgraduates’ perception towards work-based assessments and finally Theme 4, the accidental role reversal. There was high level of agreement amongst the participants on the value of a speciality training curriculum. However, the data also suggest the potential for work-based assessments to be counter-productive with respect to learner mindset and how they can impact the learning of individuals with undeveloped psychosocial skills. Nevertheless, the data also identified benefits of other elements of the programme, such as research and peer assisted learning.

## Conclusion

A speciality training programme in endodontics should expect to build on the four clinical pillars that were identified from the GDCs curricula. However, ILOs related to endodontics are being achieved very differently in UK Dental schools, creating a wide variation of capabilities amongst general dental practitioners and new PGs, this is a situation that needs to be addressed. Within PG programmes thought needs to be placed on identifying current barriers to learning and over-coming them through actively supporting the learning cycle at the core of every endodontic teaching and assessment. This is a situation that will also help ensure the product of training is capable of being a lifelong learner. To achieve this transformation two phases have been proposed. Phase one includes achieving a consistent baseline of clinical skills amongst newly starting PG’s. The second phase would build on the undergraduate ILOs and psychosocial skills to begin the development of specialist level skills through regular feedback, deliberate practice and reflection.

## Table of Contents

<b>Abstract.....</b>	<b>2</b>
<b>Title .....</b>	<b>2</b>
<b>Introduction .....</b>	<b>2</b>
<b>Aims .....</b>	<b>2</b>
<b>Methods .....</b>	<b>2</b>
<b>Results:.....</b>	<b>3</b>
<b>Conclusion.....</b>	<b>3</b>
<b>Table of Contents .....</b>	<b>4</b>
<b>Table of Tables.....</b>	<b>6</b>
<b>Table of Figures .....</b>	<b>6</b>
<b>Acknowledgements.....</b>	<b>8</b>
<b>Chapter 1: Introduction.....</b>	<b>9</b>
The scope and practice of endodontology .....	9
The populations need for endodontic treatment .....	11
Approaches to dental education and training theoretical considerations .....	13
<b>Chapter 2: The Mapping .....</b>	<b>23</b>
<b>Aims .....</b>	<b>23</b>
<b>Introduction .....</b>	<b>23</b>
<b>Methodology .....</b>	<b>24</b>
<b>Results .....</b>	<b>26</b>
<b>Discussion .....</b>	<b>32</b>
<b>Conclusion.....</b>	<b>35</b>
<b>Chapter 3: The Survey.....</b>	<b>36</b>
<b>Aims .....</b>	<b>36</b>
<b>Introduction .....</b>	<b>36</b>
<b>Methodology .....</b>	<b>37</b>
<b>Results .....</b>	<b>38</b>
<b>Discussion .....</b>	<b>44</b>
Teaching issues.....	44
Assessment Issues .....	48
<b>Conclusion.....</b>	<b>51</b>
<b>Acknowledgements .....</b>	<b>51</b>
<b>Chapter 4: The Interviews .....</b>	<b>52</b>
<b>Aims .....</b>	<b>52</b>
<b>Introduction .....</b>	<b>52</b>
<b>Methodology .....</b>	<b>59</b>
<b>Results .....</b>	<b>63</b>
<b>Discussion .....</b>	<b>75</b>
<b>Conclusions .....</b>	<b>82</b>
<b>Chapter 5: The Final Chapter .....</b>	<b>83</b>
<b>Reflection and Feedback .....</b>	<b>85</b>

Teaching .....	87
Final Thoughts .....	89
Final Conclusions.....	91
References .....	92
Appendix 1 – The Full Curriculum Map .....	104
Appendix 2 – The Survey.....	108
Appendix 3 – Ethical Approval .....	111
Appendix 4 – The Interview Schedule.....	112
Appendix 5 – Participant Information Leaflet .....	113
Appendix 6 – Participant Consent Form .....	115

## Table of Tables

Table 1 – Listing the Main Topics .....	25
Table 2 – Similar Intended Learning Outcomes .....	28
Table 3 - Complementary Intended Learning Outcomes .....	31
Table 4 - Specialist Intended Learning Outcomes .....	31
Table 5 - Rules on Required Endodontic Treatments .....	41
Table 6 - Endodontic Clinical Exposure.....	42
Table 7 – Postgraduate Dental Training Stakeholders .....	54
Table 8 - Alternative Methodologies .....	56
Table 9 - Cate and Durnings 12 reasons to support PAL .....	80
Table 10 – The benefits and potential drawbacks of PAL.....	81

## Table of Figures

Figure 1 – The Learning Cycle .....	17
Figure 2 - Fixed and Growth Mindset Traits (Dwek 2002).....	18
Figure 3 - The Miller Pyramid.....	19
Figure 4 – Timing of Endodontic Treatment – 4 .....	40
Figure 5 – Theme 1: Postgraduates’ perception of a structured curriculum.....	64
Figure 7 – Theme 2: Postgraduates’ perception towards their speciality training .....	67
Figure 8 – Theme 3: Postgraduates’ Perception towards WBAs .....	70
Figure 9 - Theme 4: The Accidental Role Reversal.....	73



## Acknowledgements

I don't think I can express my gratitude in words; however, I'll try.

My mentors, my teachers, Professor Dawson and Professor Jarad have been guiding me since my late teens. They have been instrumental in my professional growth and have seen me change from a blue haired punk teenager to a general dentist - with normal (ish) hair. More importantly, they imparted on me the eager attitude of a lifelong learner. The irony of that is not lost on me. The final step of their years (and years) of guidance...was making me a specialist, and a very proud qualitative researcher. Who would have thought!

Dr Buckley was a late addition to the research team however was pivotal in giving me strength, confidence and conviction in my qualitative research ability.

I'll be forever indebted to the selfless amount of time and effort you have all given me over years. It is a testament to your incredible teaching abilities. It also shows so much passion for our field which I hope to emulate.

Like any good cliché, I must acknowledge my family, friends, colleagues and dogs. They have all supported me, believed in me and loved me (in differing amounts).

The road has been a long, bumpy and testing one.

I learnt a lot, and you have all taught me so, so much. My mentors and teachers have become my friends in the process.

My gratitude should not be expressed in writing, but be expressed to you through what I do next in life, armed with *all* that I've learnt... Watch this space.



## Chapter 1: Introduction

### The scope and practice of endodontology

The word endodontology is derived from the Greek language, and can be translated as ‘the knowledge of what is inside the tooth’. Therefore, the terms endodontology and endodontics concern the structures and processes within the pulp chamber and the dental pulp (2). A specialist in endodontology is referred to as an ‘Endodontist’. An endodontist is defined as a dental clinician excelling in their deep understanding of the discipline of endodontics, as well as having specialist clinical skills beyond simple competence and even proficiency (3, 4).

The dental pulp is the soft tissue located in the centre of the tooth. It forms, supports, and is an integral part of the hard tissue that surrounds it, the dentine. The healthy pulp is home to specialised cell types, which include: odontoblasts (responsible for the formation of surrounding dentine); fibroblasts, blood cells; and neurons (2). Together, the dentine and pulp form the pulpo-dentine complex. The pulpo-dentine complex is able to react to external stimuli through the activity of nerves, blood vessels and the immune system, as well as fluid turnover within the dentine (5). The result of the responses to external stimuli is the dentine becomes less permeable either physiologically (via increased fluid flow), or anatomically (by laying down tertiary dentine) (6).

The pulp responds to noxious stimuli through the sensation of pain. The exact mechanism over how the pulpo-dentine complex initiates pain is largely unknown (5). Several hypotheses about dental pain transmission have been proposed and widely are accepted, and include the hydrodynamic mechanism, odontoblastic transduction, and dentine innervation models (7, 8). The hydrodynamic fluid movement theory was introduced in 1966 (9), and is a theory that carried substantial weight for future research on dental pain. The complexity that underpins dental pain is due to the issue being multi-factorial. The limitations of research methods (seeking appropriate ethical approval, obtaining funding, replicating oral conditions in a lab based model) makes it even harder to produce reliable data to substantiate those theories. The reality of dental pain may be a combination of all the above.

Endodontology aims to manage situations where the homeostasis of the pulpo-dentine complex is disrupted. Once the nerves and blood vessels within the pulpo-dentine complex

are involved, the result is excruciating pain. This clinical situation is responsible for the presentation of up to 90% of the cases in a dental emergency setting (10). Normally, immediate pain relief is managed through the combination of correct diagnosis (11), followed by the treatment options of removal of the dental pulp (known as ‘pulp extirpation’) or extraction of the tooth. Either treatment option is then usually followed by post-operative advice, including the use of over-the-counter analgesics (12).

The discipline of endodontology is an active area of research, where our understanding and available technology have advanced considerably throughout the last century. This is a situation that has also afforded constant refinements in clinical practice (13). An example of such refinements is change to the classical method of removing pulp and cleaning the surrounding dentine tissue, which was traditionally undertaken through manual filing using stainless steel files. However, through research and development, the shape, function, malleability, and even material used for the files have all been refined over the years. Nickel titanium is now the material commonly used (14, 15), either alone or in conjunction with conventional stainless-steel files. Many versions and variations of files have been developed, each claiming their own superiority (16, 17). Such advancements may have had an impact on speed and efficiency of treatment (13) but whether or not they have positively benefited treatment outcomes has yet to be determined.

However, there have been many significant variables identified in endodontic treatment that can affect the outcome. One of the most significant variables effecting endodontic success and survival is the quality and type of final restoration placed (coronal seal) following endodontic treatment (18-20). In fact, the effect of coronal seal has been suggested to be more important than technical quality of the root canal treatment (21). Contradictory research will claim that technical outcome of endodontic treatment (i.e. radiographic root apex in relation to the root filling / obturation) is just as important as coronal seal, with both factors heavily contributed to endodontic treatment failure (19, 20, 22, 23). The type of irrigation used during the endodontic treatment (24, 25), as well as the use of a rubber dam (26) have both been implicated in contributing to the success (assessed by radiographic resolution of pulpal disease, as well as absence of signs and symptoms (27)) and “survival rate” (assessed by post treatment tooth retention, regardless of presenting signs and symptoms or radiographic appearance (18)) of teeth following endodontic treatment. Interestingly, in spite of these variables, the survival and success rates of endodontic procedures have always been

relatively high, with data suggesting rates of 80% upwards (20, 22). Such data may, on the one hand, suggest that outcomes could be more linked to operator skill and knowledge, than the techniques used, which has implications for training, or on the other hand it may be that we have reached a limit of what can be done within our current understanding of pathological mechanism within a variable biological system.

### The population's need for endodontic treatment

In addition to the changes to the clinical approaches there have also been changes in the patient population requiring treatment. The National Health Statistic published June 2015 (UK) (28) reported that the population is ageing compared to data from forty years ago. The current mean UK population age of 40 years is significantly advanced when compared to that of 33 years, the mean in 1974. However, an even more significant figure is the 89% increase in the number of population aged 75 and over. Moreover, the Adult Dental Health Survey (2009) reported that since 1978, the proportion of adults in England, who were edentate, has fallen by 22%, from 28%. Currently, only 6% of the population are completely edentulous, approximately 94% of the population have at least one natural tooth. This change in ageing dynamic within the population is significant with respect to endodontics because it impacts upon the treatment need. It also involves a plethora of considerations relevant to the clinical management of the pulpo-dentine complex (29), which is directly affected by ageing.

Therefore, the clinical need of patients is changing, with age-related complications that were rarely seen previously now becoming every day routine cases in primary healthcare setting. These age-related complications include other complex situations such as root surface caries (30), and tooth wear (31). In addition, retained teeth in the older patient tend to become subject to periodontal disease, as well as the slow progressive physiological effects of tooth surface loss that result in pulpal changes, such as the formation of pulp stones and narrowing of the root canals (32). These later changes are due to the deposition of secondary and tertiary dentine (33), as a defence mechanism to the low-grade trauma resultant from tooth wear. Such altered anatomy and changes in tooth stability create additional challenges when attempting treatments such as root canal treatment, or extractions. For example, when attempting root canal treatment on altered anatomy, complications such as perforations,

missed canals, separated instruments, improperly cleaned and shaped canals occur more frequently, all of which could ultimately lead to failure of root canal treatment (34).

Data over the ageing population also likely explain why the rate of root fillings provided has been steadily increasing world-wide. In the UK, an increasing trend was obvious with the number root fillings increasing from 800000 in 1978 to 1.2 million in 1995/96 (35, 36). However, recent data suggests the startling rise from 1970 to 1990 has plateaued. The reasons for the plateau could be a combination of things including patient education and increased awareness of dental health as well as the use of fluoridated toothpaste. The plateau could also be due to the introduction, and provision of, implant dentistry. Nevertheless, the endodontic treatment need remains considerable with NHS data, from the last three years, suggesting that at least 600,000 root canal treatments were performed annually on adult and child patients. However, this could be a significant underestimate because the current NHS 'banding' structure does not allow for accurate costing calculations. 'Band 2' covers restorative fillings, root canal treatment and extractions. Therefore, if one was to assume patients only had 1 root canal treatment under this branding price, root canals would cost the NHS approximately £33 million. The remuneration for endodontic treatment falling within 'Band 2' treatment could have other repercussions on the delivery of endodontic treatment. General dentists could be less inclined to offer endodontics as a suitable treatment option if the treatment would require a private referral to a specialist endodontist. Furthermore, general dentists also have to consider how much the patient is paying for the overall treatment, versus how much the patients treatment is costing the dental practice. Taking into account the hourly rate to run a dental practice (rent, electricity, staff wages), and, the cost of equipment to perform endodontic treatment. Band 2 costs would result in an absolute financial loss. This could subconsciously skew the advice given resulting in patients more likely to choose extractions over NHS, or private, endodontic treatment.

Moreover, the UK has dental treatment provision by both government sector and private sector, each with a different market. According to the British Dental Association, the ratio of the UK population attending NHS dental services versus private dentistry patients is an 85:15 split. Therefore, overall it is likely that 600,000 root canal treatments could be a fairly conservative estimate.

A further situation that often requires endodontic intervention is dental trauma, a particular problem in children (37). According to the Children's Dental Health Survey 2013 the number

of children under 16 years of age who have gone through traumatic dental injury has been steady since 2003. However, that number is approximately 10%, which is still a significant portion of children in the UK who will most likely need current and future endodontic intervention to avoid infection and retain the function and form of their dentition (38). Such complications to the pulpo-dentine complex arising from dental trauma may include pulp necrosis, root resorption, ankylosis and tooth loss (2).

In summary, people are living longer and retaining their natural teeth. Therefore, it is no surprise that there is a significant current and future demand for endodontic treatment because there will be an increasing number of older patients who need complex restorations to ensure retention of their natural teeth. This demand is in addition to the steady number of trauma cases in children age 16 and younger; which at the predicted 10% of the child population minimally represents an estimated one million cases annually. Therefore, to address this demand, there will almost certainly need to be an increase in the training of the dental workforce. However, in a recent survey of North West Dentists, only one quarter of the total participants reported taking part in any hands-on teaching and / or didactic lectures in endodontics (39). Therefore, although there seems to be a need for further training, currently there would seem to be little action towards it. Moreover, the training that is being provided needs to be fit for purpose. Obtaining an understanding of the stakeholders' demands could help determine what the 'purpose' is, in 'fit for purpose' training. This will be one of the aims of 'Chapter 2: The Mapping', whereas 'Chapter 3: The Survey' will determine how the 'purpose' is executed.

### Approaches to dental education and training theoretical considerations

Traditional approaches to dental education emphasise what students must be taught and were subjected to 'discipline-based' methods of teaching and training that lacked integration and focused on passing tests of knowledge. Unfortunately, reducing the dental training to instructional objectives predisposed students to mechanical approaches to learning (40). These problems were eloquently summarised by David Chambers who stated:

*'In that [discipline-based] system, the questions of integrating biomedical and other knowledge, and of incorporating the behavioural sciences as a natural part of dental practice could be unanswered in the abstract – or left entirely unanswered by some students.'*

He went on to highlight:

*'By focusing on what students must be able to do on their own when they begin practice, responsible creativity and diversity will be promoted in what we do as dental educators...'*

Through this statement Chambers was referring to the move towards outcomes-based education (OBE), which emphasises what the learner must be able to do through defining intended learning outcomes (ILOs). A further refinement of the OBE approach has been to nest ILOs into competencies, an approach known as competency-based education (CBE). Following the publication of the Francis report (41) there have been significant changes over the delivery of dental education in the UK, especially with respect to establishing personal values and professional competence. The GDC has reacted by their moving undergraduate education away from the curricular content approach of the First Five Years (42) toward the OBE/CBE Preparing for Practice (PfP) in 2012, and its subsequent revision in 2015 (43). In keeping with this educational trend, ILOs have been developed for endodontics and their interrelationship between various key stakeholders is the focus of Chapter 2: The Mapping.

One of the major problems that result from a CBE approach is over how each provider interprets, and subsequently teaches, and assesses how the ILOs have been met (44). This is crucial, as if the teaching and/or assessment is not up to the task of establishing competency then graduates from these programmes will not be appropriately prepared. Worryingly, in both medical and dental education significant concerns have been expressed over current approaches, and furthermore there is anecdotal evidence that this may be leading to an increase in patient harm (45, 46).

To circumvent such concerning issues, being a specialist endodontist should signify that the individual has undergone an appropriate training which has objectively demonstrated that

they have fulfilled the required competencies set by the governing bodies, for their level of specialisation, on sufficient occasions. Such training would require the employment of evidence-informed teaching and assessment methods, and be subject to demanding quality assurance processes (47).

The starting point is to understand what competency is, a subject that has been debated over the years. In essence, competency is suggested to be the aggregate of different components or latent attributes, which are relatively distinct from each other (48). However, despite years of research and debate, no consensus exists on any taxonomy of clinical professional competence, and none of the ‘traits’ are well-defined. However, an often-quoted definition of professional competency is:

*‘The habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values, and reflection in daily practice for the benefit of the individual and the community being served’ (49)*

This definition highlights the complex and interconnected nature of the facets of competency, as well as giving important clues over the high regularity of any approach to reliably assess it, which is an important consideration further highlighted by a more recent definition of competence by Govaerts et al (50):

*‘(the) ability (of an individual) to adopt and to flexibly apply and develop knowledge and skills in the face of evolving circumstances’*

Such definitions provide a great deal of challenge to the development of CBE curricula that must be capable of constructively aligning (51) their teaching and assessment practices to the ILOs for the valid and reliable demonstration of competent graduates. This is because approaches must not only be able to address and track multiple learning domains, but also assess the degree of learner adaptability as circumstances change (52). A further consideration that arises from these definitions is the sheer scale of competency due to the potentially limitless number of circumstances that could occur in the clinical setting. Therefore, in CBE, it may be better to move thoughts away from the global concept of competency, and more toward the concept of *capability* (53). Capability, is the range of

circumstances over which an individual is competent. Therefore, for the purposes of a CBE curriculum considering capability is arguably the better approach because the range of contexts is both definable and limited, which enables better alignment between teaching, assessment and ILOs.

Having gained an understanding of capability (contextualised competency), it is next necessary to explore approaches to achieve this. A good starting point would be to consider how an individual learns through reference to the learning cycle (Figure 1 – The Learning Cycle).

In the class room setting starting point for learning is with some form of teaching. The degree of understanding/skill development following the teaching is established with some form of assessment. The purpose of such assessment is to establish what has been understood/developed and to identify what requires further development. This later process is driven by feedback, followed by self-reflection on behalf of the learner, goal setting, and deliberate practice leading to a change in self-regulation (54, 55). Therefore, within the learning cycle the purpose of assessment is to support learning, rather than being the goal of learning, and lifelong learner, should be viewed as a continuous cycle (see Figure 1 – The Learning Cycle). ‘Figure 1 – The Learning Cycle’ is an adaptation of Kolb’s learning cycle (56). The adaptations to Kolb’s original learning cycle was to ensure it is more suited to healthcare professional learners. Kolb’s initial learning cycle centres on 4 main stages. The first stage is the planning or trying stage of what one has learned. This is followed by having a learning experience, reflecting, then concluding. On a basic level, the essence of the learning cycle remains true to Kolb’s. Important additions including feedback, goal setting, deliberate practice and self-regulation will be the overriding theme throughout every chapter of this research project.



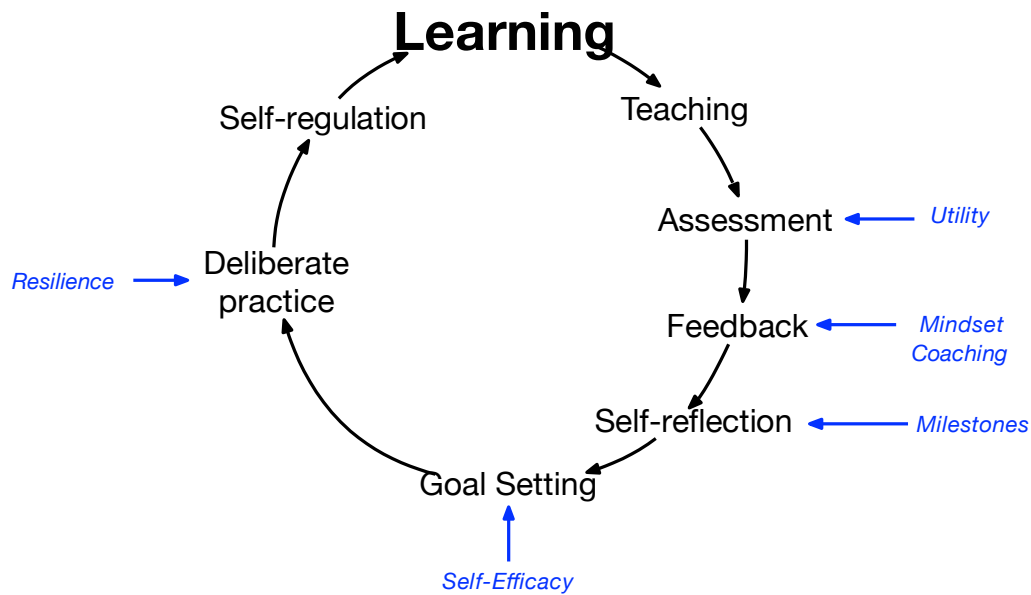


Figure 1 – The Learning Cycle

When the learning cycle (Figure 1 – The Learning Cycle) is operationalised within an OBE model it is the trainee’s responsibility to learn from their own mistakes. Unfortunately, available data suggest that 57% of university students have fostered a ‘spoon feeding’ mentality with respect to teaching (57), and goals that simply focus on passing tests. In this situation, once the test is passed the learning is done, so the cycle remains incomplete. This seeming misalignment over student focus relates to changes to School education and may have arisen as an unintended consequence of league tables and the primacy of National testing (46). Irrespective, there is little doubt that the educational impact has been the development of a fixed mindset in a significant number of students, that presents a significant barrier to their following the learning cycle (46).

Therefore, it is important to obtain an understanding of the ‘Mindset model’(58) and the potential repercussions this model may have on dental education. In this model, two basic types of mindsets are described, fixed and growth (*Figure 2 - Fixed and Growth Mindset Traits*).

FIXED MINDSET		GROWTH MINDSET
<ul style="list-style-type: none"> <li>• SOMETHING YOU'RE BORN WITH</li> <li>• FIXED</li> </ul>	SKILLS	<ul style="list-style-type: none"> <li>• COME FROM HARD WORK.</li> <li>• CAN ALWAYS IMPROVE</li> </ul>
<ul style="list-style-type: none"> <li>• SOMETHING TO AVOID</li> <li>• COULD REVEAL LACK OF SKILL</li> <li>• TEND TO GIVE UP EASILY</li> </ul>	CHALLENGES	<ul style="list-style-type: none"> <li>• SHOULD BE EMBRACED</li> <li>• AN OPPORTUNITY TO GROW.</li> <li>• MORE PERSISTANT</li> </ul>
<ul style="list-style-type: none"> <li>• UNNECESSARY</li> <li>• SOMETHING YOU DO WHEN YOU ARE NOT GOOD ENOUGH</li> </ul>	EFFORT	<ul style="list-style-type: none"> <li>• ESSENTIAL</li> <li>• A PATH TO MASTERY</li> </ul>
<ul style="list-style-type: none"> <li>• GET DEFENSIVE</li> <li>• TAKE IT PERSONAL</li> </ul>	FEEDBACK	<ul style="list-style-type: none"> <li>• USEFUL</li> <li>• SOMETHING TO LEARN FROM</li> <li>• IDENTIFY AREAS TO IMPROVE</li> </ul>
<ul style="list-style-type: none"> <li>• BLAME OTHERS</li> <li>• GET DISCOURAGED</li> </ul>	SETBACKS	<ul style="list-style-type: none"> <li>• USE AS A WAKE-UP CALL TO WORK HARDER NEXT TIME.</li> </ul>

Figure 2 - Fixed and Growth Mindset Traits (Dwek 2002)

An individual with a 'Fixed Mindset' believes their intelligence cannot be expanded. Therefore, failure in an assessment is interpreted as a failure of oneself, and not simply at the level of the assessment. Conversely, an individual with a 'Growth Mindset' believes that their intelligence can be developed through endeavour and effort in response to feedback. It is clear from the previous discussion that within the healthcare profession, it is the 'Growth Mindset' that is required in professional competence. This is because being in possession of a growth mindset is fundamental to the reflective processes that drive changes to self-regulation (54), which in turn underpin the continual strive for improved performance that is essential for patient care (46). Dawson and Fox explored the origins of student's maladaptive behaviours, their impacts on learning, and the limitations of current approaches to the assessment of competency when undertaken in the current learner behavioural background. They highlighted that goal setting abilities, resilience, and self-efficacy are of critical importance to the learning cycle (Figure 2), yet lacking in the fixed mind set individual.

Considering, the importance of assessment in the learning cycle and the maladapted behaviours that it can be associated with, it seems imperative to understand how assessments can drive the right behaviours and encourage the transformation of a fixed mindset individual into a growth mindset.

Approaches to the assessment of professional competency usually revolve around 'The Miller Pyramid' which was proposed by psychologist George Miller in 1990 (59). The Miller Pyramid (Figure 3 - The Miller Pyramid) is also known as the 'Competence Model'. At the

lowest level of the pyramid is ‘Knows’, followed by ‘Knows how’, ‘Shows how’ and ‘Does’, ‘Does’ focuses on what occurs in practice rather than what happens in an artificial testing situation.

Competency is seen as the midpoint on the continuum of professional growth, with ‘Beginner’ and ‘Master/Expert’ at either extreme of said continuum (60). As a general rule, the process of mastering a discipline, including but not limited to endodontics, consists of alternating tasks to achieve greater flexibility, effectiveness, and range of purpose (61).

Table 1 describes the characteristics of the transition from Beginners to Experts.

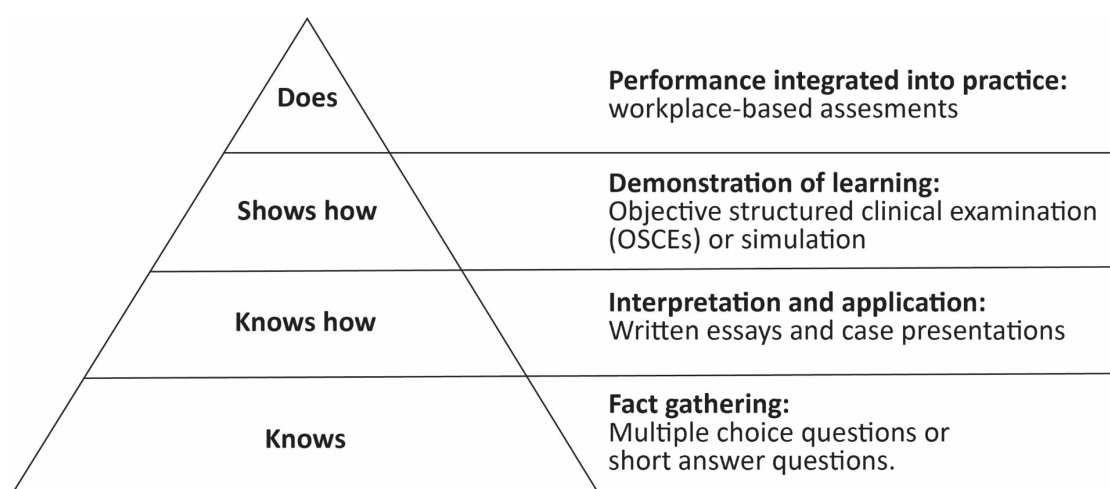


Figure 3 - The Miller Pyramid

A crucial facet of any assessment within the learning cycle is that it should measure accurately so it can identify what is known and what is not known by the learner. This is essential for the provision of feedback and good goal setting. The fitness for purpose of an assessment to do this is known as Utility. The *utility* of an assessment method was defined by Van der Vleuten (48) as a multiplicative function of variables with differential weights. These variables include validity, reliability, educational impact, acceptability and cost. Unfortunately, data suggest that many of the assessment approaches used in dental education lack sufficient utility (46, 52), a situation that likely compromises the feedback received and the subsequent reflection, irrespective of the mindset of the learner.

Feedback is always predicated on assessment and if that assessment is inaccurate, feedback will be at best ineffective and at worst harmful. It can provide negative guidance and lead to lost opportunities which result in educational inefficiency (62). Moreover, data suggest that the quality of feedback can have a variable effect on the trainee (63). In a meta-review, 33

variables were identified and linked to task performance (e.g. task complexity), feedback reception by trainees (e.g. self-esteem), observation (e.g. focus) and finally feedback provision (e.g. the form and content). The magnitude of feedback's impact varies from large and positive to small and insignificant (64). Feedback has also been shown to produce negative effects on performance in more than a third of cases. Explanations of these variable effects often focus on the feedback itself: whether it is qualitative or quantitative; who delivers it; how it is delivered; when it is delivered and the situational and individual characteristics of the instructor and learner (65).

Being able to learn from one's mistakes is an essential ability for life, and it is not surprising that the GDC regard being able to appropriately reflect is essential for a career in dentistry. Known for improving understanding, showing outcomes and promoting a desire for lifelong learning; it is also considered valuable in improving clinical competence and performance and for ensuring continual professional development (66). The physical act of writing one's reflection can improve a clinician's stores of empathy and courage (67). Rita Charon went as far to say the following about reflection in the context of clinical training:

*'Writing that affects the reader is art'(67).*

This demonstrates the perceived power of reflecting on one's educational experiences, during the journey of dental training. In the learning cycle, reflection should take place following good feedback provided by the educator to the trainee. That way, reflection and feedback can feed into deliberate practice. This would support both the learning cycle and the ideal end product, the lifelong learner.

Reflection has now been incorporated into undergraduate, postgraduate, and continuing medical / dental education. However, the evidence to support and inform these interventions remains largely theoretical (68). Reflection approaches are often flawed because some applications have taken an excessively instrumental approach to the evidencing of reflection, and while they have provided useful templates or framing devices for recording individualistic reflective practice, they potentially have distorted the original intentions (69), becoming a task to complete.

Good goal setting should follow self-reflection. The learner should be able to set goals for themselves. Goal-setting ability is also known to be intimately related to self-efficacy, defined as *one's belief in their own ability to succeed in specific situations or accomplish a task*. One's sense of self-efficacy can play a major role on how one approaches goals, tasks, and challenges. However, as discussed earlier for many learners this ability is lacking due to their fixed mindset. A situation that must be addressed through curricular inclusion over psychosocial development.

Deliberate practice is the last link in the learning cycle and brings the process to fruition. The acquisition of superior performance in medicine is closely related to engagement in practice with feedback during medical training (55). It has been speculated that after the end of organised medical or dental training, continued access to conditions for deliberate practice, as well as feedback on daily medical practice, might allow healthcare professionals, especially specialists, to keep improving their performance to achieve even higher levels. However, the act of deliberate practice requires effort, and a trait of the fixed mindset is that the effort would be pointless. A situation that provides further challenge to inclusive curricular design.

The final stage of the learning cycle is change to self-regulation, which in academic contexts, requires that students exercise a suite of powerful skills: setting goals for upgrading knowledge; deliberating about strategies to select those that balance progress toward goals against unwanted costs; and, as steps are taken and the tasks evolves, monitoring the accumulating effects of their engagement (54). Anecdotally, and according to theoreticians, the most effective learners are self-regulated (70). It does seem to apply to growth mindset undergraduate dental students who are learning clinical skills for the first time. Fixed mindset students may struggle to self-regulate and may need more appropriate coaching by knowledgeable staff. This mindset coaching takes place through informed feedback provided by the educator and tailored to maximise the trainees' benefit (65). It is unquestionable whether the self-regulation trait is desired in both undergraduate and postgraduate dental trainees.

To demonstrate facets of competence, the GDC curriculum recommends using a combination of work based assessments and summative written 'examination' as the methods of assessment. The written examinations have varied formats that include essays, multiple choice questions (MCQ's), short answer, and long answer questions. Different assessment

methods have been compared over the years, with no general consensus as to which method is superior. Each method may have some specific merits dependent on what facets require testing. For example, MCQ's come in two formats, single best answer and true/false. However, data supports the notion that single best answer are better suited to the assessment of the higher levels of Bloom's taxonomy (71) essential for clinical practice such as data interpretation, problem solving and decision making compared with MCQ's that merely expect recalling isolated facts (72). The evidence also points towards MCQ's as being superior to 'open-ended' type questions and essays at an 'exit-level' summative assessment. This is explicable using a theory of mental models, which might predict that the multiple-choice format will have higher validity and reliability (73). However, irrespective of format care must be taken to ensure that the approaches used have the utility sufficient to appropriately drive the learning cycle.

In summary, creating a lifelong learner, in terms of a specialist in endodontics, appears to be extremely complex when considering all the multiple and very different elements needing to come together in a short time period. What makes the task even more complex is perhaps the lack of available evidence, specifically, in terms of perception of postgraduates training in the UK. This research project is aiming to gather data to help establish the best educational approach to support the professional development of a specialist endodontist.

## Chapter 2: The Mapping

### Aims

- The aim of this section is to establish the expected level of knowledge and experience in endodontics gained from undergraduate dental education to inform the baseline expectation for a postgraduate in endodontic speciality training.
- Provide insight into the common pillars of practice that would form a ‘golden standard’ for endodontic training

### Introduction

Data suggest that in the UK and beyond, less than ideal endodontic treatment is being provided, and significant levels of endodontic failure are still prevalent (74-76). Moreover, this is likely to be a growing issue because of the rising trend of endodontic treatment need in the population (see Chapter 1: Introduction). Indeed, poor technical quality of root canal treatment remains a significant risk factor for apical periodontitis (19, 23). A fact recognised by the European Society of Endodontology (ESE) who stated:

*“...consequences of escalating endodontic problems in primary care is their referral to secondary and tertiary care providers. The patients’ options are either, further care by a more highly trained dentist with special expertise in endodontics, or tooth extraction.”*

The latter, tooth extraction option, leading to potentially more expensive prosthetic options. Such concerns suggest that there is an increased training need for specialist endodontists. Initially, these specialists will be derived from the generalist dentist population who have likely been exposed to both undergraduate training, and, continued professional development (CPD) courses. Therefore, for effective specialist training, it is essential to understand the likely base-level of knowledge and skill provided during undergraduate studies.

In the UK, undergraduate dental training is governed by the General Dental Council (GDC). The GDC is the main stakeholder and their role includes setting standards for Universities to

uphold during the training period. Being a regulator for the dental profession also includes prescribing the required Intended Learning Outcomes (ILOs) for endodontic training. Within an outcome based curriculum mapping is a crucial process because it informs the integrative alignment of the teaching and assessment against the intended learning outcomes (77). Mapping is also a process crucial to addressing academic gaps and misalignments of purpose, so improving the overall coherence of a curriculum and, by extension, its validity (78). Therefore, mapping provides the ideal approach to inform the baseline starting point of a postgraduate about to undertake speciality endodontic training because it allows direct comparison of the ILOs required for undergraduate and specialist endodontic training. In addition, analysis of the mapping data allows for any similarities between undergraduate and postgraduate ILOs, enabling the identification of those ILOs that have conserved importance, for both generalist and specialist with respect to endodontics.

## Methodology

Due to this project being specific to UK Dental schools, the GDC ILOs were chosen for the mapping exercise. Moreover, using the same stakeholder documents for both undergraduate and postgraduate ensures consistency between topics, terminology and of course overall outcomes serving the same population needs.

The postgraduate learning outcomes (79) 'SKILLS' section was used as the map's main framework. The document does include other aspects that were examined however not included in the main map. The other aspects were: 'Objective Criteria', 'Knowledge of Skills', 'Attitudes', 'Teaching', 'Learning Methods', and 'Assessment'.

Paper copies were obtained of both the postgraduate curriculum and the undergraduate equivalent - 'Preparing for Practice' (43). Similarities and differences between learning outcomes were identified manually through highlighting text within PDF copies of the documents within ADOBE Acrobat DC software. The highlighted learning outcomes were subsequently transferred to a Microsoft Excel spreadsheet and organised into a numbered list (See Appendix 1 – The Full Curriculum Map- Column A). Abbreviation of dental terms took place to simplify the appearance of the map – Treatment = Tx, Manage/Management = Mx and Patient = pt. The total number of topics mapped from the postgraduate curriculum was 14 main topics with 77 learning outcomes (Table 1 – Listing the Main Topics). Following



completion of digital transfer, the document was checked against the Excel map to confirm correct representation and accuracy.

Linear alignment took place in the adjacent column on the excel sheet (Column B in Appendix 1 – The Full Curriculum Map), with similar undergraduate curriculum learning outcomes. Similar initial manual highlighting took place. These learning outcomes were identified as either ‘identical’ or ‘introductory’ to the main framework of postgraduate endodontic training. The learning outcomes were labelled in a numbered and decimal fashion, similarly to the original GDC document - see Appendix 1 – The Full Curriculum Map.

<b>Topic Number</b>	<b>Topic Title</b>
1	Examination and Diagnosis
2	Development of Treatment Strategies and Plans in Endodontics
3	Health Promotion and Prevention of Diseases Including Infection Control
4	Pulp Therapy
5	Non-surgical root canal treatment
6	Non-surgical root canal retreatment
7	Surgical root canal treatment
8	Dental Traumatology
9	Pain Control and Management (acute & chronic), analgesia, sedation and anaesthesia
10	Management and Administration
11	Clinical Governance
12	Teaching and Communication
13	Clinical Imaging
14	Research

*Table 1 – Listing the Main Topics*

## Results

Out of the 76 postgraduate learning outcomes identified from the initial framework, a total of 37 undergraduate learning outcomes aligned to 37 postgraduate learning outcomes.

Therefore, out of the 77 postgraduate learning outcomes, only 39 align with those of specialism in endodontics.

Two different patterns between the ILOs were noted when the undergraduate alignment took place. The first pattern noted was that some ILOs were indeed very similar for both undergraduate and postgraduate (Table 2 – Similar Intended Learning Outcomes). In some instances, the resemblance would almost be word for word. An example of that would be the Topic Title '*Examination and Diagnosis*' (Row 2); in which all but 2 postgraduate learning outcomes had matching undergraduate counterparts (**See Appendix 1 – The Full Curriculum Map**). This emphasises how important the Regulators consider it for all dental healthcare professionals to employ a holistic approach towards patient examination and diagnosis. Incorporating all aspects of special investigations is equally the job of both general dental practitioner and specialist in endodontics. Although, it is also acknowledged that a specialist has further learning outcomes to increase likelihood of reaching a diagnosis in difficult cases which involve working with a multi-disciplinary team and being able to delegate (e.g. Row 33 in Appendix 1 – The Full Curriculum Map). It is clear that the foundations for both generalist and specialist appeared similar. Another example of identical alignment applied to matters of '*consenting patients*' (Row 13 in Appendix 1 – The Full Curriculum Map), demonstrating that healthcare professionals of all stages have to have similar capabilities in assessing the patients' intellectual capacity before undertaking any dental treatment.

Some learning outcomes from the postgraduate curriculum fell under two undergraduate learning outcomes (e.g. row 13 from the postgraduate curriculum aligned to both 1.5.3 and 1.5.4 from the undergraduate curriculum). Conversely, some undergraduate learning outcomes were multiple statements and therefore were able to be aligned to two separate postgraduate learning outcomes (e.g. 1.14.8 from the undergraduate curriculum aligned to both 44 and 47 from the postgraduate). 'Table 2 – Similar Intended Learning Outcomes' provides a summary of the identical ILO's.

<b><u>Similar Intended Learning Outcomes</u></b>	
<b>Postgraduate Learning Outcomes</b>	<b>Undergraduate Learning Outcomes</b>
Complete a thorough examination of the patients (3)	Undertake an appropriate systematic intra and extra-oral examination (1.2.2)
Oral mucosa and related structures, periodontium, dental hard tissues (4)	Assess, manage periodontal and soft tissues (1.11.1) & Describe and explain to pt. impact of periodontal health on overall Tx plan and outcomes (1.11.2)
Make appropriate diagnoses (5)	Formulate a differential diagnosis / diagnoses and from there a definitive diagnosis (1.4.2)
Take into account any systemic factors likely to have a bearing on the above (6)	Identify general and systemic disease and explain their relevance to oral health and their impact on clinical treatment (1.1.4)
Advise on the possible and probable outcomes of the treatment options (15)	Monitor and review treatment outcomes (1.7.3)
Use appropriate methods and technologies to prevent infection during Tx, between pts and staff and any transport between lab / clinic (25)	Implement, perform and Mx effective decontamination and infection control procedures (1.8.2)
Confidently and efficiently assess pts presenting with painful conditions (66)	Recognise and Mx pts acute oro-facial and dental pain (1.9.1)
Communicate effectively and empathically with colleagues at all levels (71)	Explain the need to take responsibility for establishing personal networks with local dental and medical colleagues, specialists and other relevant individuals and organisations (1.7.10)
Treat pts, carers, colleagues fairly and in line with the law and promote equal opportunities (73)	Treat all patients with equality, respect and dignity (1.7.1)

Utilise critical appraisal skills and be able to apply in research evidence (80)	Critically appraise approaches to dental research and integrate with patient care (1.1.2)
--	---

Table 2 – Similar Intended Learning Outcomes

The second pattern is a sense of ‘levelling’ and ‘staging’ – with some knowledge and theory being introduced in undergraduate training. This basic knowledge and theory is converted into practical skill, deep knowledge, enhanced and refined skills that are taken to ‘expert’ level during specialist endodontics training. An example of this would be *‘Surgical Root Canal Treatment’* (Row 54 in ‘Full Map’), a topic which appears to be exclusively in the specialist domain in terms of clinical skills. This topic had a total of 5 learning outcomes under the postgraduate specialist training curriculum. These learning outcomes included specialist level skill in endodontic surgery treatment planning, refined surgical skills and exceptional skills in soft/hard tissue handling. Whereas, only one undergraduate learning outcome aligned to the whole topic of Surgical Root Canal Treatment, which was to *‘Recognise the role of surgical management of peri-radicular disease (1.14.7)’*. While the skills and deep subject knowledge are exclusive to the endodontist, the topic is expected to have been introduced at an undergraduate level. The learning outcomes with an ‘introductory’ nature that aligned and seemed to complement the specialist skills in the postgraduate curriculum are summarised in Table 3 - Complementary Intended Learning Outcomes.

<b><u>Complementary Intended Learning Outcomes</u></b>	
<b>Postgraduate Learning Outcomes</b>	<b>Undergraduate Learning Outcomes</b>
Use all appropriate investigations to diagnose oral problems (9)	Undertake relevant special investigations and diagnostic procedures (1.2.4)
e.g. radiographs. Sensibility, haematological, microbiology tests & articulated study casts (10)	including radiographs (1.2.4)
Weigh options against each other and succinctly describe pros and cons of each (12)	Formulate an appropriate treatment plan, synthesising patient assessment and diagnosis data (1.5.1)
Communicate the facts in terms of appropriate to the intellectual capacity of the patient (13)	Explain the principles of obtaining valid patient consent (1.5.3) & Obtain consent (1.5.4)
Communicate clearly/succinctly the impact of oral status, proposed Tx and quality of life to the patient (14)	Identify, explain and manage the impact of medical & psychological conditions in the pt (1.7.2)
Delineate strategies/plans according to skills of other clinicians involved in the care of the pt (18)	Refer patients for treatment or advice when and where appropriate (1.5.5)
Demonstrate Rx planning and management skills in dealing with medically compromised / Special needs pts (29)	Identify, explain and manage the impact of medical and psychological conditions in the patient
Demonstrate Rx planning and practical skills necessary for restoring endo Rx teeth using a range of techniques (31)	Manage restorative procedures that preserve tooth structure, replace missing or defective tooth structure, maintain function, are aesthetic and long lasting, and promote soft and hard tissue health (1.14.5)
Apply knowledge of occlusion in the assessment and management of endodontically involved teeth (32)	Asses and manage caries, occlusion, and tooth wear (1.14.1)
Communicate clear Rx plans to colleagues including other dental specialists, GDP's, DCP's where appropriate (34)	Identify and explain when and how to refer patients for specialist treatment and apply to practice (1.13.5)

Judge when vital pulp therapies are indicated (36)	Assess, diagnose and Mx the health of the dental pulp and peri-radicular tissues (1.14.6)
Execute vital pulp therapies various clinical procedures with efficiency and skills (37)	Including Rx to prevent pulpal and peri-radicular disease (1.14.6)
Demonstrate proficiency in general patient management (42) [Non-surgical RCT]	Evaluate the need for more complex Tx and refer accordingly (1.14.10)
Demonstrate proficiency in controlled manipulation of hand / automated instruments and materials (44)	Determine the prognosis of appropriate non-surgical Tx to manage pulpal and peri-radicular disease in uncomplicated deciduous and permanent teeth (1.14.8)
Communicate clearly and effectively with clinical colleagues and pts on matters of prognosis, appropriate restoration, supportive care and monitoring (47)	Determine the prognosis of appropriate non-surgical Tx to manage pulpal and peri-radicular disease in uncomplicated deciduous and permanent teeth (1.14.8)
Inform pt of the risks & limitations of procedures for coronal disassembly and non-surgical re RCT (50)	Recognise the risks of non-surgical root canal treatment and how to manage them (1.14.9)
Specialist level skill in the planning of investigative and corrective surgery (55)	Recognise the role of surgical management of peri radicular disease (1.14.7)
Exchange clearly and appropriately laboratories handling biopsy specimens (59)	Manage appropriate clinical and laboratory investigations (1.2.3)
Demonstrate specialist-level efficiency and confidence in the Mx of dental trauma (61)	Recognise and manage dento-alveolar and mucosal trauma (1.9.3)
Mx the psychological and physical well-being of the pt and accompanying person during acute trauma Mx and follow up (63)	Prevent, diagnose and manage patient anxiety appropriately, effectively and safely (1.7.4)
Communicate clearly and effectively on the patterns of tissue reaction and consequences following trauma (64)	Identify the need for and make arrangements for follow-up care (1.9.4)
Appropriately Mx the use of all standard local anaesthetic and analgesic regimes (67)	Prevent, diagnose and manage pain appropriately, effectively and safely (1.7.5)

Identify patients requiring specialist or interdisciplinary care for the Mx of non-dental and chronic pain conditions (68)	Explain the role and organisation of referral networks, clinical guidelines and policies and local variation (1.7.9)
Utilise appropriate communication / presentation / negotiation / counselling / appraisal / mentoring skills (70)	Explain, evaluate, and apply to clinical practice psychological and sociological concepts and theoretical frameworks of health, illness, behavioural change and disease (1.1.13)
Utilise appropriate negotiating and listening skills to achieve the desired result (72)	(3.1)...includes pts with anxiety, breaking bad news, discussing alcohol / smoking
Produce and update patient information material (82)	Recognise and take responsibility for the quality of services and devices provided to the patient (1.8.3)
Interpret radiographic images and write an accurate radiographic report (88)	Explain and apply scientific principles of medical ionizing radiation and statutory regulations (1.1.11)

*Table 3 - Complementary Intended Learning Outcomes*

‘Table 4 - Specialist Intended Learning Outcomes’ is a summary of other learning outcomes that emerged exclusively as specialist domain but with minor introductory undergraduate alignment.

<b>Exclusively Specialist Endodontists Intended Learning Outcomes</b>
Management of combined periodontal-endodontic lesions
Root Canal Re-Treatment
Teaching and Presentation Skills
Clinical governance including involvement and learning role in: patient surveys, audits, patient information material.

*Table 4 - Specialist Intended Learning Outcomes*

## Discussion

Having a curriculum that is designed with ILOs to produce the right ‘product’ is an essential function of an outcome-based educational approach. However, a ‘fit for purpose’ curriculum must also take into account many factors, including population needs, epidemiology of disease (80), the emphasis on prevention of disease, and patient education, as well as the changing approaches of how students learn. The aim of this project was to inform the baseline educational level for the postgraduates about to undertake a specialty training in endodontics. A further aim was to attempt to identify ‘golden standard pillars’ of endodontics that are fully applicable to dental clinicians of both generalist and specialist level.

A total of 10 identical ILOs emerged between undergraduate and postgraduate. The majority (7/10) were related to examination, diagnosis, outcome of treatment, and cross infection processes. The rest (3/10) were in relation to professional values with regards to treating patients and colleagues, as well as research awareness and critical appraisal skills. The 10 identical learning outcomes can be further summed up into four ‘golden pillars’ that likely underpin all clinical practice. These appear to be equally applicable to both undergraduate and postgraduate.

- 1. The ability to thoroughly assess the patient, examine them holistically*
- 2. Following the examination, be able to reach a definitive diagnosis, before treatment planning and treating the patient*
- 3. Awareness of current and relevant research and employ an evidence-based approach towards treatment provision*
- 4. Treat all colleagues, patients and others with respect and honesty*

It is of no surprise to see the importance of correct patient assessment and diagnosis (before implementing a treatment plan) reiterated to such an extent in both curricula (81). However, phrasing ambiguity would lead one to believe the examination and diagnostic skills of both undergraduate and postgraduate remain the same. This is quite likely to be misleading because although the ILOs may be the same the expected level of training required between undergraduate and specialist postgraduate is clearly not the same. It is therefore, imperative



to obtain a deeper understanding of how ILOs are currently implemented with undergraduates by way of a survey throughout UK Dental Schools.

It is of note that, there were no identical learning outcomes related to clinic skills, and all were in fact complementary and basic in nature. This supports the notion that the majority of endodontic related clinical skills are only required to be at an introductory level during undergraduate training. However, there appears to be cohesive and consistent approach between undergraduate to postgraduate, which supports the aim of developing a specialist from a generalist. This consistent approach to ILOs within endodontics is confirmed by the 27 complementary learning outcomes being able to be aligned.

In the UK, an undergraduate would be expected to reach a minimum of 'safe beginner' (43) level while performing root canal treatment on uncomplicated deciduous and permanent teeth. A situation that recognises both skills limitation and the need to ask for help. An expectation comparable to the American Association of Endodontics (AAE) who defined that *simple endodontic cases are ones whereby achieving a predictable outcome is possible by a competent clinician with limited experience*. The AAE highlighted factors which may contribute to the level of simplicity of an endodontic case including tooth related factors such as single rooted teeth, and teeth with an uncomplicated radiographic appearance. In addition, other factors like mouth opening, and patient mobility are also important considerations. Such criteria potentially make finding suitable uncomplicated cases difficult, which would have a bearing on the quality of undergraduate training, which would in turn have an impact on the minimal baseline starting point of a postgraduate. Furthermore, there were circumstances where the ILOs were too non-specific and open to vast interpretation e.g. the undergraduate ILO of '*Assess, diagnose and manage the health of the dental pulp and peri-radicular tissues*'. Such ambiguity could give too much flexibility when implementing undergraduate training. Furthermore, it may also allow an undergraduate to complete their training having lacked some imperative endodontic related training. The postgraduate curriculum, on the other hand, has a detailed itemised list of specialist level expectations. This ranges from all aspects of vital pulp therapy, to management of primary root canal complications (including iatrogenic damage), to full surgical management of both endodontic elective cases as well as cases of orofacial trauma (

Table 3 - Complementary Intended Learning Outcomes and Table 4 - Specialist Intended Learning Outcomes). While an undergraduate may be exposed to some of these clinical experiences in theory, they are not currently GDC ILOs.

Overall, analysis of the undergraduate ILOs supports the conclusion that the objective of undergraduate training is to create a critically thinking clinician who is aware of, and be able to apply, a limited endodontic skill set. Having self-awareness regarding one's own skills appears to be a crucial step during the undergraduate training. Without a solid basis for examination skills at undergraduate level, it may be extremely difficult to enhance that skillset during postgraduate training. Self-awareness may also create a more harmonious referral process, which is another complementary learning objective. Even though the gaps in knowledge and skill between undergraduate endodontic training and postgraduate endodontic training were identified from the ILOs, the supplemental training needed beyond a BDS is not clear, nor is the baseline. This is because work experience, which takes place following completion of undergraduate training and ceases when postgraduate training begins, is not accounted for in this map. This map is looking at the stakeholders learning outcomes during formal training only. Hence, the postgraduate baseline identified from undergraduate learning outcomes here would be the minimal expectation. Potentially, any additional skills obtained in specific work experience would be the differentiator between potential trainees. Furthermore, having ILOs being made available by the GDC does not necessarily mean they are being met.

Therefore, in order to fully inform the development of a postgraduate in endodontics, a deeper understanding of the variation in undergraduate training with respect to how the ILOs are being met must be obtained. There may indeed be a wide variation amongst the approaches towards teaching and assessment, which would greatly impact the end product. The variation in teaching and assessment could have repercussions including very different endodontic skills and capabilities between general dental practitioners and the future potential postgraduates.

## Conclusion

Overall, our data suggest that a specialty training program in endodontics should expect to be able to build on the 4 clinical pillars encapsulating the 10 identical ILOs that were identified. However, it may have to start from zero with regards to the specialist skills, including:

1. Non-surgical root canal re-treatment including management of primary root canal complications
2. Surgical root canal treatment
3. Management of perio-endo lesions
4. Teaching and presentation skills

In addition, approaches to achieving the remaining complementary ILOs (Table 3 - Complementary Intended Learning Outcomes) would be largely dependent on the baseline undergraduate training. To understand this further a survey of UK Dental Schools over how ILOs are being achieved and how endodontics is being taught and assessed is required.

## Chapter 3: The Survey

### Aims

The aim of this part of the investigation was to:

- Gain insight into the potential variation in capability of people entering into specialist endodontic training through evaluating the range of experience, along with the teaching and assessment approaches used in undergraduate endodontic education within the UK.

### Introduction

The foundations of competency in endodontic practice are established during undergraduate training. Therefore, to gain insight into the variation of clinical capability of individuals entering into specialist endodontic training it is necessary to understand the variability in undergraduate training and the degree of appropriate clinical exposure.

In 1991, Drummer (82) undertook a survey of all UK dental schools, and some schools in Europe and the United States, to establish the pattern of undergraduate endodontic teaching. He concluded that the ‘teaching of root canal therapy [in the UK] was given lower priority than that in some schools in Europe and the USA’. In addition, *‘limited time [was being] devoted to the preclinical practice of root canal therapy...This lack of practice is likely to lead to a poor understanding of the principles involved, and certainly leaves little time for the student to develop the necessary practice skills’*. These are important findings because there will be a significant number of dentists who qualified in this period currently teaching endodontics. A repeat of this survey undertaken in 1997 (83), was more encouraging with data suggesting that there had been an increase in the *‘time and priority’* given to endodontics within the undergraduate curriculum. However, the authors noted that *‘in most instances, staff teaching endodontology have no specialist training’*, a fact when combined with the potentially poor undergraduate training could be a cause for concern.

Since 1997, there has been no update in the UK over the standard or state of undergraduate endodontic education. This is especially surprising considering the focus of the GDC moving towards competency based education because there is a large emphasis on having well-defined learning outcomes for future dentists that must be met through quality assured

teaching and assessment processes (43). This is quite a different expectation over the delivery of endodontic education compared to the last time it was nationally and officially surveyed (83). Moreover, at that time, data suggested that recently qualified general dentists were not satisfied with their undergraduate endodontic undergraduate training with the general perception that UK dental schools did not adequately prepare students for endodontics in practice (84).

To more fully understand the issues over undergraduate endodontic training, the European Society of Endodontics (ESE) undertook a survey on a much wider scale when compared to the previous study (83), and encompassed every European Dental School. Although they had a relatively low response rate, the data demonstrated significant differences and inconsistencies over the: endodontic knowledge; approaches to assessment; and, the experience required to establish competency. For example, during undergraduate training, the amount of experience required to qualify as a general dentist ranged from zero endodontic cases to almost 100. Although it's accepted that learning is not the simple product of the number of 'times' a skill is repeated (85), a difference between 0 to 100 will undoubtedly have an educational impact (86). Moreover, the type of training undergraduate dental students are exposed to will directly shape how the population is being 'endodontically managed', so the degree of variation between schools is likely to be consequential.

Due to the educational importance of these issues, and the historical nature of much of the existing data, we wished to establish the profile of undergraduate endodontic training in the UK. Such data would provide both insight into how endodontic undergraduate training has been influenced by competency based approaches driven by the GDC, and provide the baseline to inform the development of postgraduate specialist training approaches.

## Methodology

To gain additional insight into training in undergraduate dentistry, we obtained permission from the Association for Dental Education in Europe (ADEE) Special Interest Group for Endodontic Teachers via Professor John Whitworth (University of Newcastle School of Dental Sciences, Professor of Endodontology and ADEE Chair) to continue "Phase 2" of their survey. Results of their survey were not published, however, the data was presented and discussed during an Endodontics Teachers Meeting (Barcelona ESE conference, 2015). This

survey was appropriate for our purpose and enabled direct correlation of new data with existing. We aimed at increasing the existing response rate of England and Wales Dental Schools from 7 to 12 – thus obtaining a full response rate of 100%.

This survey (Appendix 2 – The Survey) explores a range of issues including:

1. Cohort size
2. Timing of endodontic clinical exposure
3. Location of endodontic teaching
4. Profile of teachers, staff to student ratios
5. Number of endodontic cases required
6. Endodontic clinical experience exposure
7. Supply of suitable cases
8. Formal Testing, Continuous assessment, reflection and remediation.

The five Dental Schools who did not initially respond were contacted. A digital copy of the survey in a 'Microsoft Word' document format was emailed by the primary researcher following official request, along with access to a digitally hosted copy on [surveymonkey.co.uk](https://www.surveymonkey.co.uk). There was a 'Free text' section added to the end of each question in the survey to allow respondents to freely type and express all perceived relevant facts.

A total of five UK dental schools were sent a link to the survey via email.

A follow-up and reminder was sent 7-10 days later to all non-responding schools. In addition, a second email was sent with a request either for clarification or for additional information, when needed. The schools were assured that the data will be confidential, and the results will be anonymised. Data was initially stored digitally on [surveymonkey.co.uk](https://www.surveymonkey.co.uk) and then transferred to a secure Microsoft Excel spreadsheet for later analysis.

## Results

### Response

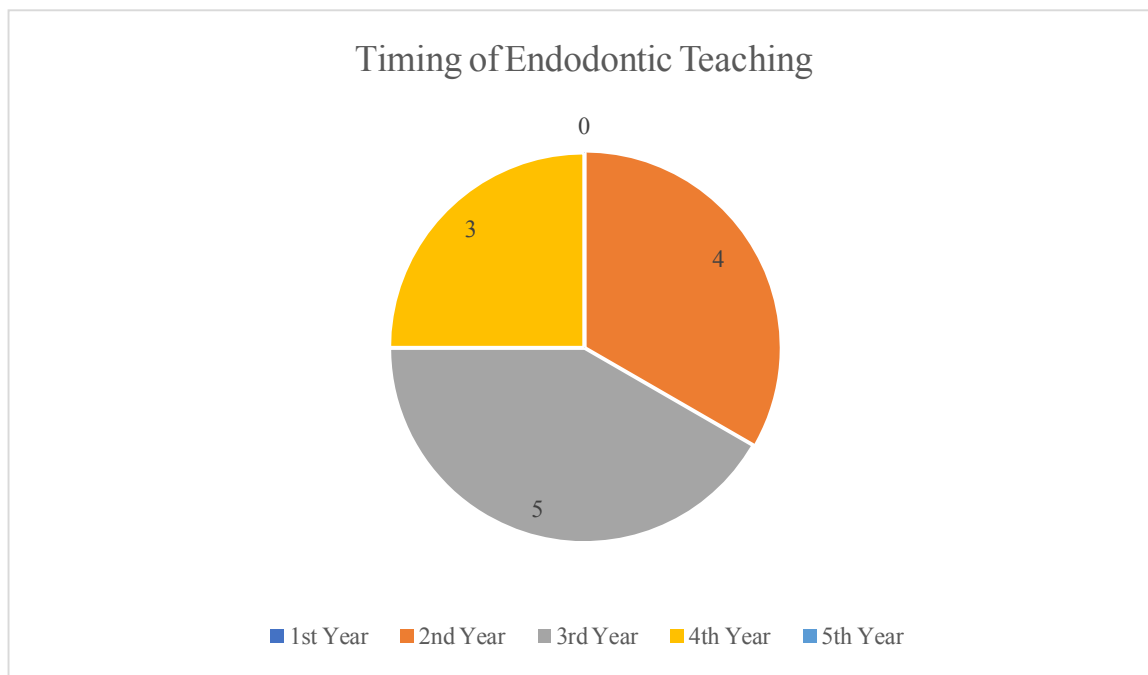
Completed questionnaires were received from 5 schools, representing an overall 100% response rate when compiled with the 7 initial respondents. This makes a total of 12 schools that were surveyed.

### Cohort Size

The number of students within each year of study varies between the schools and is related to factors that include re-sit students and individual University targets of local and international students. However, the mean number of students per year was found to be 82. The overall range was 51 to 160 undergraduate dental students per year, with more than half the Dental schools having approximately 75 undergraduates in each year.

### Timing of Endodontic Teaching

The data in Figure 4 – Timing of Endodontic Treatment indicates that the majority of dental students (N = 9 dental schools) begin to perform endodontic procedures on patients in their 2<sup>nd</sup> and 3<sup>rd</sup> year of study (N = 4 and N = 5 respectively). A much smaller portion (N = 3) only introduce students to endodontic treatment on patients during their 4<sup>th</sup> year of study. All schools allow students to perform endodontic procedures throughout the entirety of their clinical time, and not on defined periods of their clinical training. Two schools indicated staging complexity of treatment for each year. For example, 2<sup>nd</sup> year of study are allowed to perform pulp caps, 3<sup>rd</sup> year of study are allowed to perform single rooted endodontics etc. It is important to highlight that some schools offer 4-year undergraduate training program, while the majority of Dental Schools in England and Wales offer 5-year training programs. Some schools offer a combination of both 4 or 5 year options. Our results would apply to the majority of Dental Schools in England and Wales. It is not possible to divulge when the 4 year programs introduce endodontic teaching, as that could compromise the anonymity of the respondents.



*Figure 4 – Timing of Endodontic Treatment – 4*

*Dental schools starting endodontic teaching in 2<sup>nd</sup> year, 5 Dental schools start in 3<sup>rd</sup> year and 3 Dental schools start endodontic teaching in 4<sup>th</sup> year.*

### Location of Teaching

All dental schools (N = 12) had mixed Restorative / Conservation clinics where endodontic treatment would take place. Only (N = 3) schools had dedicated endodontic clinics within their Dental school. (N = 7) of Dental schools also utilised community and outreach programs to further expose undergraduates to endodontic clinical experience.

### Profile of Teachers

All Dental Schools had a combination of general dentists, and those who specialise in endodontics, teaching the subject. This also included dentists with special interests. Only (N = 3) of the Dental Schools highlighted that the core teaching in simulated labs was led by specialists, and complex endodontic cases on clinics were scheduled when a specialist Endodontist is available. No Dental schools had only specialists in endodontics (or special interests) teaching the subject.

### Staff to Student ratios

The average staff to student ratio across the UK schools was 1:6. The smallest staff to student ratio being 1:4 (N = 3 of Dental Schools) and the largest ratio being 1:12 (N = 1 of Dental



Schools). Many Schools highlighted that the ratio varies considerably based on the type of clinic, the year of undergraduates on the clinics, and the complexity of endodontic cases scheduled.

#### Rules on Numbers of Cases

The majority of the Schools (N = 7) set a minimum number of cases that undergraduates must complete before sitting exit exams and qualifying as general dentists. The remaining Dental Schools (N = 5) emphasised consistency in competence of skills, as well as some form of reflection over an arbitrary number of cases. With regards to the Schools that do specify a number, the approach appears case-dependant and a lot of factors are considered, which may include variables such as tooth type (i.e. single rooted or multi rooted), complexity of endodontic cases, number of fully completed cases, and the number of canals obturated. In addition, 6 Dental Schools provided their students with exact rules on number and type of cases which are highlighted in

Table 5 - Rules on Required Endodontic Treatments.

Dental School 1	1 single rooted endo 1 molar endo  Both done to a satisfactory standard
Dental School 2	- 20 Canals OR - 10 multi-rooted
Dental School 3	10 canals from access to obturation (2/10 to be multi-root cases)
Dental School 4	- 6 single rooted teeth - 3 molars
Dental School 5	1 Molar endo and 2 other cases from access to obturation
Dental School 6	<u>Within the Dental School:</u> 6 teeth (Minimally included 2 complex cases) <u>Within 'Outreach':</u> 10 canals (counted as additional experience - student may only do part of the endodontic procedure)

*Table 5 - Rules on Required Endodontic Treatments*

## Experience

The data show that no undergraduate dental student would be able to obtain a BDS degree without performing root canal treatment, including molar root canal treatment. However, half (N = 6) of Dental Schools state it is possible for an undergraduate to not be exposed to re-root canal treatment. In addition, (N = 9) of Dental schools do not expose their undergraduate dental students to Cvek pulpotomy, partial pulpotomy on permanent teeth, apexification procedures, or perforation root repair. Furthermore, (N = 8) of Dental Schools say it's possible for a student to gain no experience of direct pulp capping, which is double the number of schools who say indirect pulp capping (N = 4) may also not be experienced. Details are described in Table 6 - Endodontic Clinical Exposure.

<b>Endodontic Skill</b>	<b>% (N)</b>
It is possible for a student in my school to gain NO experience of indirect pulp capping	4
It is possible for a student in my school to gain NO experience of direct pulp capping	8
It is possible for a student in my school to gain NO experience of Cvek, partial pulpotomy on permanent teeth	9
It is possible for a student in my school to gain NO experience of full pulp chamber pulpotomy on permanent teeth	7
It is possible for a student in my school to gain NO experience of root canal treatment	0
It is possible for a student in my school to gain NO experience of molar root canal treatment	0
It is possible for a student in my school to gain NO experience of root canal re-treatment	6
It is possible for a student in my school to gain NO experience of conducting an apexification procedure.	9
It is possible for a student in my school to gain NO experience of conducting a perforation repair.	9

*Table 6 - Endodontic Clinical Exposure*

A few respondents did indicate that experience happens to be 'case-by-case' dependent. This is based on what the supply of suitable cases is like. A large effort is placed on, minimally, providing a simulation experience with a large majority of the skills listed above due to the difficulty in finding suitable patients.

### Supply of Suitable Cases

The vast majority of Dental Schools (N = 10) are concerned about the limited supply of suitable cases. A situation further supported by 'Free Text' comments such as... *"There is an abundance of complex cases, however straightforward cases are limited"*.

### Formal Testing

The data suggest that formal assessment is undertaken on both skills and knowledge of endodontics. 11 out of the 12 Dental Schools test endodontic knowledge, but only (N = 8) of Dental Schools formally test their students with respect to endodontic skills. Details provided over how endodontic knowledge is tested included OSCE's, written examinations, case reports, clinical competencies and VIVA presentation. However, it is important to note that how well these processes were operationalised, and to what level of rigour was not established by the survey.

### Continuous Assessment

The data indicated that continuous assessment and the of feedback was carried out either electronically or with a paper-based system. The majority (N = 11) Dental Schools use an electronic system. Only 1 school had a paper-based system, but they commented that they are currently *"In the process of moving everything electronic"*. More than half of Dental Schools (N = 7) have a process to review the progress of students at intervals during the clinical years, with different skills and factors being taken into account during the progress review that could include: isolated competencies within endodontic treatment (e.g. moisture control); overall endodontic treatment quality; professionalism; and, subject knowledge.

### Reflection

All (N = 12) of Dental schools encourage reflection. Some Schools explained that this takes place on clinics during endodontic treatment sessions. However, for (N = 2) of Dental schools, reflection was also incorporated in written form via tools such as endodontic log books or portfolios that must be completed and formally submitted.

## Remediation

The data suggested that when students were deemed to lack sufficient competency, (N = 7) of Dental Schools had some form of remediation processes which took place. The remaining respondents (N = 5) emphasised extra sessions of practical simulation in phantom head labs and/or provision of a bespoke action plan. A minority of respondents (N = 2) have an unspecified informal approach, where remediation was at the discretion of the department.

## Discussion

Compared to the situation in 1991 (82), these UK data suggest that there have been significant improvements in the position and focus on endodontics in undergraduate curricula. However, the data seem to highlight continuing, and potentially significant, issues with respect to variations in teaching and assessment that could impact upon the ability of graduates to both undertake endodontic management in general practice, as well as the potential base line level when entering into specialist training.

It is important to acknowledge that self-reported data (such as surveys) come with limitations and bias. *Response bias* refers to the respondents' tendency to respond a certain way, regardless of the actual evidence they are assessing. This is thought to be subconscious and cannot be helped in the majority of instances (87). However, honesty and 'image management' could heavily influence the type of responses collected, thus potentially further compromising the raw data. No methodology comes without limitations. Considering the limitations with surveys, they will continue to be a popular methodology because of their utility and feasibility.

## Teaching issues

There are apparent consistencies and inconsistencies throughout UK Dental Schools with respect to teaching endodontics. While the majority (N = 8) of Dental Schools introduce the subject of endodontics (skills and knowledge) during the 2<sup>nd</sup> or 3<sup>rd</sup> year of undergraduate training, N = 4 do not introduce endodontics until 4<sup>th</sup> year of training (Figure 4 – Timing of Endodontic Treatment). In a congested curriculum with time restraints, Dental Schools have

many administrative decisions to make which perhaps play a major role in the timing of endodontic teaching.

However, with respect to the timing of endodontic training, it is important for Dental Schools to also consider the amount of experience that the undergraduate would have acquired before the introduction of endodontics. An undergraduate student in their 2<sup>nd</sup> year may have limited experience in clinical dentistry, having just been introduced to using a dental handpiece. An expectation for them to be able to fully immerse themselves in endodontic skills and transfer what minimal experience they possess is challenging. A 3<sup>rd</sup> year undergraduate would have a little bit more clinical experience, but still be very inexperienced with respect to number of times they would have used a handpiece clinically (on a patient) in that time period.

Unpublished data from the University of Liverpool suggest that at the start of 3<sup>rd</sup> year, less than 50% of undergraduates have actually performed a direct restoration on a patient.

Moreover, by the end of the 3<sup>rd</sup> year, and entering into 4<sup>th</sup> year, the average experience is only around 15 direct restorations. In terms of clinical skills development, endodontics has always been perceived by undergraduates, and dentists, as a technically demanding treatment to undertake (88). The leap from ‘simple fillings’ skills to endodontic skills is substantial.

Assuming 4<sup>th</sup> years have an upper hand by practicing clinical dentistry for a year or two longer than their counterparts, this should give them a better chance at skills transfer.

Conversely, consideration has to be given to the fact they would have less time to apply those skills on a real-life patient (before graduating), a situation that could compromise the learning cycle because less clinical time could lead to reduction in the opportunity to receive high quality feedback and undertake deliberate practice (55). Therefore, in considering these matters a fine balance must be struck, and the data suggests that thought needs to be placed over when endodontics is introduced. Such thoughts need to encompass ‘drilling’ experience, skill transfer timing, and sufficient time to allow the undergraduates to deliberately practice after good feedback with subsequent good reflection.

There has been a previous recommendation that endodontics should be taught by specialists (83). This recommendation would appear not to be evidence based and simply reflecting expert opinion. The basis of the recommendation seemingly stemmed from the lack of priority given to undergraduate endodontic teaching. Our data suggest that this recommendation is not being widely met, as 100% of Dental Schools had a mixture of general dentist and specialists who teach the subject. Moreover, only 25% of Schools ensured

that the simulated skills were run by specialists in endodontics. Taken together, these data suggest that the majority of endodontic education is currently being led by non-specialists. Bearing in mind the likely limited end-product of undergraduate training, having a mix of specialists and generalists teaching the subject could be beneficial because it would allow different levels of qualifications and viewpoints to provide different levels of feedback.

While the profile of teaching staff remains relatively consistent, as does the location of teaching. With 100% of Dental schools running mixed Restorative clinics where endodontic treatment would take place, only 25% had dedicated endodontic clinics. Running a dedicated endodontic clinic could allow undergraduates to immerse themselves in the subject. Based on personal experience and anecdotally, the author noted that these clinics allow undergraduates to pre-plan endodontic-related queries and leave the clinic with a plethora of knowledge that seems challenging to understand without a discussion. Moreover, these endodontic-related queries tend to present after undergraduates have attempted endodontics on real life cases. However, more data needs to be gathered to assess whether or not dedicated endodontic clinics are beneficial to undergraduate development. Furthermore, it would also be of use to establish how such interventions impact of subsequent graduate development during vocational training.

Overall, the findings over inconsistencies in timing of teaching, profile of teachers, and type of clinics could have a massive bearing on the variation in skills amongst general practitioners. When compiled with our data suggesting that a significant number of educators are worried about the supply of suitable endodontic cases, it creates a concerning background for the current and future of endodontic education.

Our data suggest a further challenge to undergraduate endodontic education appears in the form of patient supply, which could be one of the biggest barriers. Patient supply is a significant problem, with the vast majority of Dental Schools fearing a low number of suitable cases for their undergraduate trainees. The GDC ILO's indicate that an undergraduate must be able to undertake uncomplicated endodontics on permanent and deciduous dentition (43). However, there is a wide margin for what is accepted as uncomplicated endodontics, discussed in Chapter 2 – The Mapping. Furthermore, the level of difficulty is not a static state, because most endodontic cases can indeed be simplified. In other words, an endodontic case that is perceived as 'High' difficulty by one clinician can be modified by an experienced clinician into a procedure that is educationally acceptable for

undergraduate training. For example, a severely broken-down molar can be periodontally addressed by a qualified dentist with advanced periodontal surgical skills, capable of providing surgical crown lengthening. This procedure results in an increase of the clinical height of the broken down crown of a tooth by the removal of the coronal portion of the periodontium together with crestal bone (89). Therefore, by increasing crown length, based on AAE criteria, the restoration moves from 'high' to 'medium' difficulty becoming within the scope of undergraduate training. Another example of simplifying a case to fulfil undergraduate ILOs would be of a sclerotic or calcified tooth. That is, a tooth with obliterated root canal anatomy, not visible on a diagnostic radiograph. An experienced clinician can endodontically access the tooth and ensure a suitable glide path is provided. An endodontic 'Glide path' is a smooth radicular tunnel from canal orifice to physiologic terminus (90). Achieving that in a sclerotic tooth would make the case complexity drop from 'high' to 'low'. This process would have complementary benefits on the experienced clinician simplifying the case especially if these clinicians are postgraduates also training. Therefore, such arguments suggest that the undergraduates could potentially have access to more suitable cases, if there are specialist staff available to simplify cases.

However, the data suggest that current approaches to tackle the issue of low suitable endodontic cases is by utilising the simulation labs. This brings to the forefront any concerns over the quality of simulating endodontic cases, as well as educational impact of simulation in a 'phantom head' lab. Simulation in dentistry is an essential part of undergraduate dental education, as it allows mastery of essential foundational skills before developing more complex skills (91). Data suggest that students appear to respond positively to the use of simulation skills as a method of learning, and developing clinical skills (92). Our data demonstrates that it remains an integral part of delivering endodontic education. Some Dental Schools regularly encourage simulation, in cases where there is a lack of suitable endodontic cases and patients. While simulation has been shown to be effective in the teaching of basic science and clinical knowledge, Ottestad et al showed that 'nontechnical skills' such as teamwork and communication could also be taught and improved in suitable simulation settings (93). Teamwork refers to a group of healthcare professionals working together to achieve the same (or a similar) goal, whereas communication refers to the trainee's ability to verbally relay a message to achieve the goal set. More studies are needed to see if simulation training improves patient outcomes (94).

## Assessment Issues

In terms of measuring knowledge and skills related to competency, literature is scarce with only 150 articles published over the past 30 years (95). This number is relatively small considering how many Dental Schools there are worldwide. This number is also small considering how important assessment is in dental education and may be a contributing factor to the current inconsistencies within Europe. The degree of difference between schools with respect to assessment is most concerning. This is because the available data suggest assessments represents a critical component of education, it not only informs decisions over competence (52, 96), but also informs crucial stages of the learning cycle such as self-reflection and deliberate practice (See Chapter 1). Furthermore, as discussed in the introduction, the format and ethos in which assessment is operationalised are likely to have significant impact over student behaviour towards learning (46). Principal among these issues is students thinking of assessments as an ‘event’.

The data suggested that a range of assessment methods were being employed. These included a written format of assessment. However, even if operationalised in an ideal manner this format is limited to ‘Knows’ and ‘Knows how’ (59) and therefore, is not sufficiently sophisticated for the full assessment of competency where the level of ‘shows how’ and ultimately ‘does’ is needed (46) (see Chapter 1: Introduction).

The Objective Structured Clinical Examinations (OSCE) (97) is often considered the gold standard for evaluating clinical performance at the level of ‘Shows how’ (59). The OSCE is an instrument of assessment that if used properly can provide an assessment that is demonstrably reliable and valid, as well as a format able to provide detailed information about the performance of an individual in the assessment. Furthermore, the OSCE has been suggested to provide information over the potential quality of the postgraduate training program (98). The OSCE was introduced in 1975 (97), and consists of a circuit of stations connected in series, with each station devoted to assessment of a particular competency using pre-determined guidelines or checklists (97). However, with reference to previous discussion (Chapter 1) over learner mindset, predictably students often focus their studies on what they think will occur in an OSCE, so it can have a poor educational impact (99), examples of which include:

- Students learning the checklist rather than having a deeper understanding of the skill (100)
- Checklists created difficulty comparing student’s competencies within, and across,



institutions (101)

- The artificial exam settings and the lack of opportunity to improve performance and reflect
- Being subject to the ‘Hawthorn’ effect (102), where students modify behaviour in order to pass the test
- The OSCE being limited to a single context of the skill, and current theories suggest that competency requires assessment across multiple contexts (48).

Regardless of the above limitations, the major drawback of the OSCE is that it cannot assess the facet of competency at the level of ‘Does’ (59). Our data show that there is no standardisation amongst the wide-ranging approaches towards endodontic assessment being employed when assessing at the level of ‘Does’. This ranges from on-site reflection following completion of a clinical session, to summative exams that test endodontic knowledge. Without a ‘triangulated’ approach, e.g. by longitudinally monitoring students on clinics, it would be difficult to measure the level of ‘Does’. Measuring the ‘Does’, with the current lack of suitable cases, will undoubtedly have a severe impact on endodontic education.

All Schools encourage reflection. However, it is the manner of reflection which is important (103), and how it drives the learning cycle. This data was not collected but it is essential to ensure that the approach does not simply turn it into a task to do, rather than an innate response to support the learning cycle.

The data suggest that remediation seems to be managed case by case, in terms of how developmental outliers are dealt with. This further exemplifies that lack of standardisation amongst the training received by the newly graduated general dentists. This lack of standardisation likely creates a wide range of capabilities which could have repercussions on the abilities of the newly qualified dentist, who may one day become the new postgraduate about to undertake specialist training.

The data suggest that there is an attempt to ensure students are exposed to certain endodontic experiences, some Dental Schools offer further simulation as remediation, for cases which may not always be guaranteed on clinics. An advantage of simulation in this instance would

be the ability for the educator to standardise the learning/assessment environment. In addition, the majority of Dental schools prescribe a list of required numbers to hit (Table 5 - Rules on Required Endodontic Treatments). However, 42% emphasised that they would rather instil correct reflection and high-quality patient treatment provision, which is in line with Chambers work who stated candidly:

*“...Stereotypical single-rooted endodontic procedures applied in the same fashion to all patients do not demonstrate competency. Students must show that they understand the theoretical foundations for endodontic treatment well enough to make adaptations appropriate to the natural variations that are encountered in practice” (104).*

Irrespective of this aforementioned wisdom, 58% of Dental schools still apply a number, and not variation rules. However, if appropriate feedback is given and evident following each ‘number’ achieved, available evidence would support the argument that there is merit in repetition of skills and aiming to increase experience (95). However, the benefits to repetition in clinical dentistry have to be balanced against the psychological ‘placebo’ effect that repetition doesn’t play a major role in developing true professional competency if the focus is on simply completing the task and not on the learning from it (85). Teaching dentistry in a ‘numbers-driven’ manner could likely foster the wrong attributes in the newly graduating general dentist as opposed to the life-long learner stakeholders demand (46). With reliable evidence so scarce, it will be extremely challenging to find the right balance between providing enough ‘number’ (appropriate cases) and doing ‘enough’ for repetition. More importantly, emphasis should be placed so that these numbers must not be tackled mindlessly but enveloped in reflective thinking and useful staff-to-student feedback. Moreover, it is likely that the aforementioned numbers needed would be variable and personal to each individual learner.

## Conclusion

The data suggest that there is large variation in the endodontic training received by undergraduate dental students. Although it could be argued that the learning outcomes are being met due to their vague and ambiguous nature. The variation of assessment practice, patient access, and reflective practice would likely have serious consequences on the learning and experience that would cast doubt on the capability and/or quality of the product produced. Moreover, there is little evidence that the assessment approaches being undertaken have sufficient utility to establish competency or address the growing problem of learners with fixed mindsets, which could lead to task avoidance. Therefore, it is likely that the variability of the graduate entering onto specialist training will need to be addressed in the design of such programmes.

## Acknowledgements

A big and special thank you to the European Society of Endodontology, Professor John Whitworth and ADEE. They fully supported this part of the research project by kindly providing the team with their previous survey template and previous available data.

## Chapter 4: The Interviews

### Aims

#### **The aim of this section is to:**

- Investigate the delivery of learning outcomes identified by the mapping exercise and survey
- Provide data to enable identification of any shortfalls and inform future best practice through gathering the perceptions and opinions of postgraduates on the programme of study

### Introduction

A review of the available literature suggests that across Europe, there are 3 different governing bodies describing the postgraduate outcomes required for ‘Speciality training in Endodontics’ (3, 79, 105). Moreover, the content of these differing outcomes has overlapping objectives with respect to role and skill sets required. This is a situation that provides validity to the argument that endodontics is a specialist field within dentistry.

In the UK, the relevant stakeholders with respect to specialist endodontic training are summarised in Table 7 – Postgraduate Dental Training Stakeholders. However, it is the General Dental Council (GDC) and the Royal College of Surgeons (RCS) who govern the education. The GDC has the active role in setting ‘The Curriculum for Specialist Training in Endodontics’ (last updated in 2010, see Chapter 2 for more details). This curriculum was developed in line with the principles outlined by the Dental ‘Gold Guide’ to ensure a consistent approach irrespective of where the training takes place for those who propose to enter training, those in training, and those who quality manage and administer training. Although the GDC set the training it is the RCS who are the arbitrators by monitoring progression, through: (a) quality assuring (or providing) the relevant examinations; and (b) hosting the ‘Intercollegiate Surgical Curriculum Programme’ (ISCP), which is the online portfolio for monitoring clinical development. The remaining stakeholders are concerned with the training provision.

Stakeholder	Roles and Responsibilities
<b>General Dental Council</b> (GDC)	<ul style="list-style-type: none"> <li>- A regulator for the dental profession</li> <li>- Setting standards for dental speciality training</li> <li>- Approving curricula of training (so far, 13 dental specialities have been approved including endodontics)</li> <li>- Quality assurance of training</li> <li>- Assess suitability for specialist listing</li> <li>- Awards Certificates of Completion of Specialist Training (CCSTs)</li> <li>- Manage the Specialist List</li> </ul>
<b>The Joint Committee for Postgraduate Training in Dentistry</b> (JCPTD)	<p>Working with Royal Colleges and Specialist Advisory Committees (SACs) to:</p> <ul style="list-style-type: none"> <li>- Develop curricula</li> <li>- Devise assessments and examinations</li> <li>- Make recommendations to GDC on speciality training</li> </ul>
<b>Health Education England</b> (HEE)	<ul style="list-style-type: none"> <li>- Supporting the delivery of excellent healthcare</li> <li>- Support delivery of health improvement to patients and public of England</li> <li>- Ensure workforce of today and tomorrow has the right numbers, skills, values and behaviours, at the right time and in the right place</li> </ul>
<b>NHS Education for Scotland</b> (NES) & <b>Wales Deanery &amp; The Northern Ireland Medical and Dental Training Agency</b> (NIMDTA)	<ul style="list-style-type: none"> <li>- All 3 have similar roles to HEE</li> <li>- Developing and delivering education and training for the healthcare workforce to enable excellence in health and care for its relevant population.</li> </ul>
<b>Postgraduate Deans / Directors</b> (PGDDs)	<ul style="list-style-type: none"> <li>- Working for Health Education England, NHS Education for Scotland, The Northern Ireland Medical and Dental Training Agency or the Wales Deanery</li> </ul>

	<ul style="list-style-type: none"> <li>- Quality management of specialty training programmes and posts</li> <li>- Appointment of trainees, trainers and training programme directors</li> <li>- Regular review of trainees (via robust quality management processes in place)</li> <li>- Recommendation of the award of CCST to the GDC</li> </ul>
<b>Training providers</b> (The Universities, NHS boards and Trust/health boards)	<ul style="list-style-type: none"> <li>- Provide well-supervised training</li> <li>- Ensure patient safety as well as the development of the dental workforce</li> </ul>
<b>Royal College of Surgeons</b> (Edinburgh, England)	<ul style="list-style-type: none"> <li>- Management of exit qualifications for dental specialities</li> <li>- Includes Royal College of Physicians and Surgeons of Glasgow.</li> <li>- Also includes the Royal Colleges of Pathologists / Radiologists</li> </ul>

*Table 7 – Postgraduate Dental Training Stakeholders*

Currently, specialist training in Endodontics takes a minimum of three years and requires passing the Membership in Endodontology / MEndo (previously referred to as Membership in Restorative Dentistry / MRD) exit exam set by the RCS. Entry onto a speciality training programme requires trainees to be on the GDC register at the time of taking up the training post, even if it is in the form of a temporary registration. However, to gain a Certificate of Completion of Specialist Training (CCST) for entry on to the specialist UK list, trainees must have secured full GDC registration. Funding for these speciality training posts comes from three sources recognised by Higher Education England (HEE), NHS Education for Scotland (NES), The Northern Ireland Medical and Dental Training Agency (NIMDTA), or the Wales Deanery. These funding sources are:

1. HEE, NES, NIMDTA or the Wales Deanery funded
2. NHS Trust or Board / University / Board / University / another provider funded

### 3. Self-funded (trainee receives no salary for the duration of the post)

From the trainee's perspective, the source of the funding makes no difference to the training they receive. The quality of training and the management of the training are irrespective of the source of funding. However, the source of funding for the trainees could be a major source of motivation and therefore influence behavioural patterns. The process commences with obtaining a National Training Number (NTN) through applying via a relevant Deanery. The Deaneries require potential candidates to meet essential and desirable criteria. If a candidate meets the 'essential' criteria they are long-listed, and 'desirable' characteristics refine that list into a short list of suitable candidates. Following the short listing there are additional parts to the selection process. A clinical assessment which could include operative dentistry (preparing a crown or bridge, in simulation) and an interview. This process is assumed to select candidates of higher calibre, better suited for the position. However, it is often undertaken through simulation, a situation that can lead to variability with respect to the quality of simulation in dental assessments (discussed in Chapter 3 – The Survey), and their choice in this process. Moreover, additional variations in external pressures can occur when considering a home student recruited by the NHS would not have to consider tuition fees, while a self-funded postgraduate has the burden of education financing. Therefore, trainees are likely to have different financial burdens and undergone different selection processes that could have educational impact.

In addition to potential variation in the 'quality' and 'motivation' of trainees, our previous data suggests that there are likely to be differences in pre-specialisation experience and their ability to learn. The learning cycle has already been discussed in detail (introduction), with data suggesting that successful learning hinges on having: (i) a curriculum that is aligned to purpose; (ii) good teaching; (iii) assessment with good utility; and, (iv) learners with appropriate psychosocial abilities. We wished to explore these key aspects of the learning cycle from the trainee's perspective to establish how the learning cycle was being supported by the current approaches being used at Liverpool University Dental Hospital.

The starting point for the project was to establish a suitable methodology to achieve our initial aims. Gathering data and obtaining the current postgraduates' perception and attitude can be a difficult process. Data suggests that obtaining an understanding of trainees' perception can lead to adoption of positive remedial measures if necessary such as staff re-

training (106). Why is perception, in particular, important? Perception is reality, and reality is the subject's truth. According to writer Joseph Reitz, *"Perception includes all those processes by which an individual receives information about his environment – seeing, hearing, feeling, tasting and smelling. The study of these perpetual processes shows that their functioning is affected by three classes of variables – the objects of events being perceived, the environments in which perception occurs and the individual doing the perceiving."* This definition would have one presume that an understanding of perception could link science and education to practicality and reality. Perception and students' experiences have shown to impact over all well-being with demanding training and heavy work load (107). What would be the ideal way to accurately capture an adult learners perceptions? Therefore, we wished to identify the types of methodology that could gather such information over perception and we considered: (a) questionnaires; (b) focus groups; and (c) interviews. Each methodology has strengths, weaknesses (Table 8 - Alternative Methodologies).

	METHODOLOGY		
	Survey	Focus groups	Interview
<b>Advantages</b>	1. Large population (20+) 2. Quick 3. Cheap to run 4. Analysis can give broad idea	1. Medium cohort (8-12) 2. Participant needs 30-60 minutes	1. Small cohort 2. Participant needs 30-60 minutes 3. Focuses on specific concerns
<b>Disadvantages</b>	1. Lacks detail 2. Inability to probe individual participants	1. Expensive to run and transcribe 2. Social desirability bias	1. Expensive to run & transcribe 2. Social desirability bias 3. Interviewer training

Table 8 - Alternative Methodologies



Extensive investigations on student perception in the medical field have been undertaken in at least 20 countries (108) including India (109), Sri-Lanka (110) and Nigeria (compared to Nepal) (111) using The Dundee Ready Education Environment Measure (DREEM). This questionnaire was developed in the mid 90's at Dundee University Medical school. The research team in Dundee included over 80 international healthcare educators who all participated in the validation process. They had a collective aim to develop and validate a universal diagnostic inventory for assessing the whole or parts of the educational environment and climate of health professions/medical schools to permit evaluation of their responses to the challenges of changing mandates and missions (112). This was due to a lack in recent, up to date, healthcare-specific instruments to measure perception of undergraduates. Roff and his team then later developed a postgraduate specific tool called Postgraduate Hospital Educational Environmental Measure (PHEEM) (113). Even though development of both DREEM and PHEEM were executed to very high quantitative and qualitative research standards, the fact remains that a questionnaire is limited in use and does not allow specific exploration and probing of specific concerns. To obtain true insight into the postgraduates' perception would be a tall order for a generic questionnaire such as DREEM or PHEEM. In the UK, the DREEM scores of healthcare professionals (nursing students, mostly) indicated a more positive than negative perception of their academic learning environments (114). An association was found between year of study and perception of academic learning environment, where first years were having more positive experiences. No other conclusions could be drawn due to the limitation of the type of data collected from a survey. The DREEM, in this case, appeared to have the ability to report observational, subjective descriptors only. Consequently, there was an inability to recommend and implement positive changes. In other cases, such as in a new Medical School in Saudi Arabia, the DREEM tool did identify areas of concern in the educational environment. The students were perceiving sarcasm from the teachers about their shortcomings and found teachers to be too strict. This allowed for corrective measures to be considered, and a suggestion of re-evaluation using the DREEM tool again upon implementation (115). What they did acknowledge in their study was the 'need for further comprehensive studies to detail in-depth specific areas of concern'. This concern cannot be addressed by repeating the same survey, as questionnaires generally do not allow for free expression. Apart from the limitations with the type of data collected, there have also been published concerns about the type of statistical analysis undertaken once data is collected following DREEM/PHEEM. There is little

consensus on how DREEM data has been both analysed and reported. A review of the literature showed that both parametric and non-parametric tests have been used (108). Major inconsistencies could lead to confusion and possible misinterpretation of the areas for change. Furthermore, this lack of statistical reliability makes it difficult to interpret the obtained DREEM data in one institution and compare it to another.

Overall, there are clear positives to using a questionnaire tool such as DREEM to obtain a sense of perception, however due to the limitations described the author felt the need to explore other tools such as semi-structured interviews and focus groups.

The ability to probe the participant by having a dialogue, as opposed to filling out a survey, maximises the potential for interactive opportunities between the respondent and interviewer because of the one to one interaction. This situation helps to establish a sense of rapport. Moreover, the interview situation has advantages over the focus group because participants in the focus group may provide answers which they believe are socially acceptable so as not to appear abnormal or deviant from the other group members. Participant willingness to provide candid responses is likely to be influenced by many factors (Table 8 - Alternative Methodologies). Socially desirable answers are referred to as 'social desirability bias', a common pattern seen in focus groups. Bias can be minimised by careful planning and thoughtful preparation of the focus group questions; however, one cannot anticipate the effect of a strong participant, or a moderator, which both may inhibit active participation. Therefore, focus groups were considered inappropriate for this project. Even though semi-structured interviews do indeed come with limitations also (116), it was considered that a case-by-case approach by semi-structured interview was the most suitable methodology to be implemented. This is because semi-structured interviews gave an opportunity to ask open-ended questions, and a forum to be able to explore opinions about the specialist training programme. They also allowed for follow up comments, to ensure there was no misunderstanding of either the question or the response.

## Methodology

Ethical approval (Appendix 3 – Ethical Approval) for the study was received by the University of Liverpool Ethics Committee (reference 201608190), and in 2016, seven semi-structured interviews were conducted with every postgraduate endodontist trainee at the University of Liverpool Dental Hospital.

### **Pilot Interview**

A pilot interview was undertaken with an independent restorative (endodontic) teacher. The attributes that were required to run a successful and informative pilot included a staff member who was heavily involved in the endodontic speciality training. The chosen teacher had full knowledge of the undergraduate and postgraduate training processes. They were involved in undergraduate and postgraduate endodontic teaching and regularly took part in work-based assessments (WBA's) process which included continuous feedback. An informal conversation following the pilot interview with participant, primary researcher, and first supervisor helped refine the schedule (See Appendix 4 – The Interview Schedule), and adjust interview techniques. The pilot interview also helped the primary researcher familiarise with the recording equipment needed to run interviews. This included a PANASONIC Dictaphone alongside a back-up Apple iPod (with attached microphone).

An independent transcriber had an opportunity to transcribe the full pilot interview and subsequently give feedback to primary researcher. The transcriber initially only required a headset, and transcribing software. A University owned DELL laptop was used to store all data on a secure University Network, in line with ethical requirements. Express Scribe Transcription Software was the transcribers preferred software choice. The pilot allowed for the entire involved team to run through the process once. Issues identified included:

1. Transcriber unable to hear parts of the pilot interview (resolved by having back up device).
2. Transcriber needing different foot pedals to allow much quicker transcription (resolved by ordering 'Infinity' USB Foot Pedal IN-USB-2).
3. Primary researcher adding more prompts underneath each main question to allow even further probing.

4. Potential nervousness of participant and how to address them (verbal encouragement, give interviewee a sense of control over the interview).

### **Sample recruitment**

The primary researcher targeted all the postgraduate endodontist trainees at University of Liverpool. All participants were either approached in person, or via a phone call. The interviews were undertaken in a separated teaching room in a private area away from general thoroughfare. All participants received an information leaflet (Appendix 5 – Participant Information Leaflet), were asked to give written informed consent, Appendix 6 – Participant Consent Form), and were assured of anonymity and confidentiality. The primary researcher is also a postgraduate endodontist trainee with some informal training in qualitative interview techniques.

### **Interview questions**

The interview questions were developed focusing on 3 main elements of the learning cycle (Figure 1 – The Learning Cycle):

- 1) The curriculum alignment in relation to the required training.
- 2) Exploring work-based assessments, feedback, and hands on clinical training.
- 3) Exploring the use of a novel, technologically informed approach to provide instant, constant feedback throughout the entirety of the training.

The questions were informed by constructs of the Theory of Planned Behaviour (117). The Theory of Planned Behaviour (TPB) is an extensively used psychological model for understanding human behaviour. It infers that people are far more likely to behave in a specific way if they form a conscious intention to do so, and this intention is the major determinant of whether a behaviour will happen. The model further suggests that the formulation of this intention is derived from the combination of three key factors:

1. Personal attitude (is a person in favour of doing it?)
2. Subjective Norms (i.e. social pressures to do something)

3. Perceived behavioural control (does the person feel in control of the action in question)

Exploring the specialist training pathway in endodontics within a socio-cognitive model provides a strong framework for measure development and analysis. The TPB has been shown to predict variations in intention and behaviour in a wide variety of activities, and thus, is a feasible theory to apply to a topic not previously explored in terms of socio-cognitive factors. Therefore, this study illustrates an initial application of this theory to specialty training and it represents the first of its kind to apply TPB to understanding the impact of speciality training in dentistry.

The semi-structured interviews encouraged respondents to discuss their perceptions and experiences freely. The broad areas to be discussed included: issues relating to the interviewees attitude towards self-development via a curriculum-based specialist training program (personal attitude); perceived attitudes (subjective norms) of colleagues and patients; and, perceived barriers to specialist qualification like work-based assessments (perceived behavioural control). More general issues were also discussed such as clinical activity (variation and frequency), research, audits, and other aspects of the course. This included any other element of the course from weekly Journal clubs, seminars, external courses and national / international conferences.

The interview schedule was developed by the primary researcher with input from supervisors (Appendix 4 – The Interview Schedule). The schedule was to be used as a guide and the respondents were allowed to lead the interviews. A limit of 1 side of A4 with 6 main questions was set. Relevant prompts (reminders) were included within each question. The prompts were potential participant answers and subsequent probing. The interviews took 25-45 minutes depending on the participant's level of engagement. The level of participant engagement was visible through a variety of clues including body language, eye contact, enthusiasm as well as the amount of information offered by participant. Participant's tone of voice also gave insight to their level of engagement - some participants spoke fluently and in a confident manner throughout, while some participants stuttered / mumbled, and were visibly anxious. They needed encouragement to speak. Some respondent answers had a lot of valuable data - answering several questions at once, before being asked the question in the schedule. The interview therefore had to be adjusted accordingly in real time. This was done

by the primary researcher during the interviews. Skimming through the prompts in the schedule allowed the interviewer to not repeat questions already discussed and try to obtain more detail without deviating off topic. A final confirmation with one sentence can be as simple as “Do you have anything else to add...” or “are you happy to move on now to the next part of the interview?”. This gave the participant freedom to elaborate further, and once again gave the participants complete control during the interview.

## **Data Analysis**

All interviews were audio-recorded and transcribed verbatim by an independent typist. The scripts were read and checked for accuracy by the qualitative researcher. Data was analysed using manual Thematic Analysis as described by Bruan & Clarke (1). Thematic analysis is a method for identifying, analysing and reporting patterns (themes) within data. Bruan & Clarke described six distinct stages of Thematic Analysis.

1. Familiarizing yourself with your data: Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas
2. Generating initial codes: Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code
3. Searching for themes: collating codes into potential themes, gathering all data relevant to each potential theme
4. Reviewing themes: checking if the themes work in relation to the coded extracts (Level 1 coding) and then the entire data set (Level 2)...followed by generating a thematic ‘map’ of the analysis
5. Defining and naming the themes: Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report: the final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis

However, the 6-phase guide emphasises that having a guide mustn’t take away from the essence of thematic analysis which allows the researcher flexibility and ‘artistic’ expression.

Text was read (and re-read) before identifying initial themes and noting common themes. A 'theme' captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set. Ideally, there will be a number of instances of the theme across the data set, but more instances do not necessarily mean the theme itself is more crucial (1). The analysis was undertaken by the primary researcher. Insights and unforeseen topics were documented. The themes were refined through a natural editing process while re-reading the transcribed data. Some infrequent codes were removed with case by case rationale and justification described in the results section.

Following initial identification, the themes were then examined in relation to the central topic of concern: postgraduate endodontic specialist training. The differing responses of individuals were examined by the available demographic variables like gender, age, home student / overseas student, and whether or not the postgraduate obtained their undergraduate dental training in the UK or not. The initial codes became focused. In an attempt to validate the primary researchers' ability to thematically analyse data, a third supervisor was invited to join the research who is an expert in qualitative research at the University of Liverpool. 'Triangulation' took place, which included a session of coding comparative available data in other clinical disciplines (nursing, medicine). The studies were picked randomly online by both researchers involved in the triangulation. The quotes found in the write up were analysed by both, at the same time, with a set time limit (e.g. 3 minutes). A discussion took place after each coding attempt which helped highlight rationale behind each researcher's process. There were minor initial differences at the start of the triangulation session that were resolved by discussion. The agreement was high throughout, so no further checks were deemed necessary.

## Results

All the postgraduates in endodontics at the University of Liverpool Dental Hospital (LUDH) agreed, to participate (n=7). Five were male and two were female. The sample had an age range of 25 to 38 (mean age of 29 years). Of the participants, five (one female, four males) had obtained a bachelor's in dental surgery (BDS) from a UK based Dental school. The remaining two participants had qualified from Dental schools based in the MENA region

(Middle East, North Africa). Four of the male of the participants were home students with NTN's and the remaining three were overseas postgraduates with no NTN's (two females, one male). Three males were 2<sup>nd</sup> year trainees (senior), the remaining four participants (two males, two females) were junior trainees (1<sup>st</sup> year). No differences were found between male and female opinions and attitudes. There were also no differences found between UK and non-UK graduates. There were differences found between home students and overseas postgraduates discussed later. There were also differences found between opinions and attitude of 1<sup>st</sup> year (junior) compared to 2<sup>nd</sup> year (senior) postgraduate trainees. Four main themes emerged with relevant codes and sub-codes.

### Theme 1: Postgraduates' perception of a structured curriculum

Figure 5 – Theme 1: Postgraduates' perception of a structured curriculum

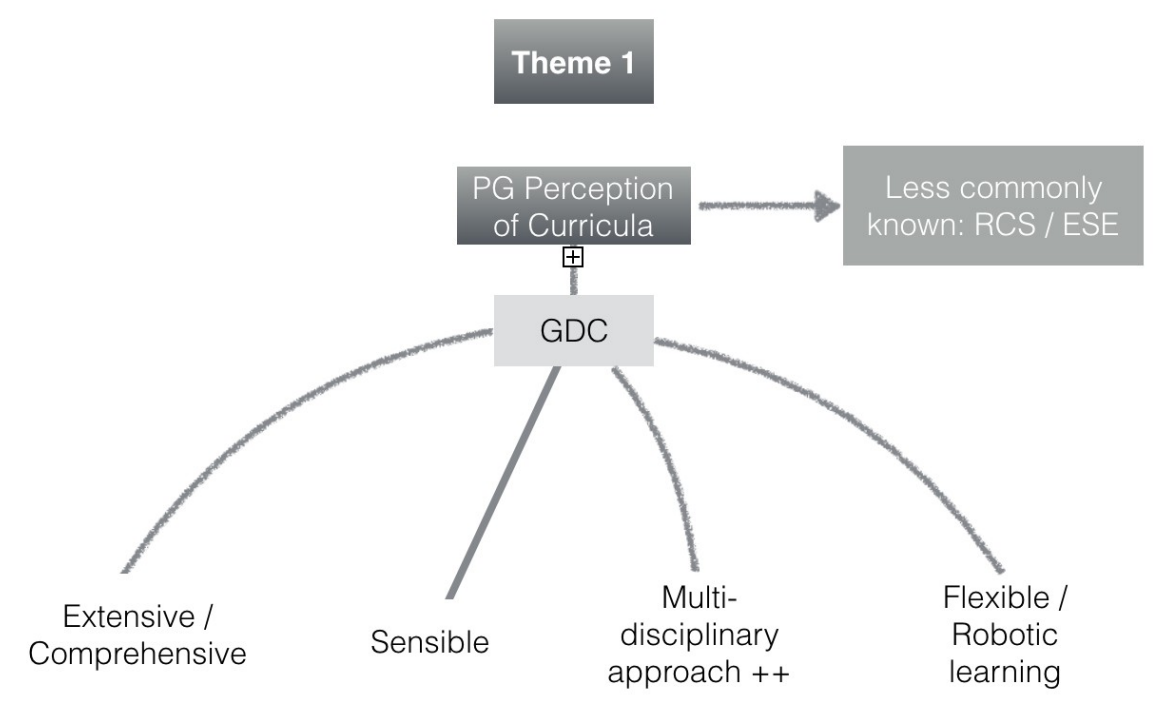


Figure 5 – Theme 1: Postgraduates' perception of a structured curriculum

- The GDC specialist curriculum was more commonly known
  - Less commonly known curricula are RCS / ESE
- It is perceived to be an extensive, comprehensive and sensible document.



- High appreciation of a multidisciplinary approached curriculum
- Fear of 'rigid' learning

All 7 respondents (100%) were aware and had come across the GDC curriculum. Only 2/7 had come across the other available curricula, and the rest are merely aware of their existence. The general consensus (6/7) was that the GDC curriculum represented a sensible document, which covered the majority of what the postgraduates perceived to be their future role as an endodontist.

**“I think it’s holistic....works on the knowledge side and the clinical side...”**

*Interview 1: Senior Trainee, International Student*

**“It’s detailed and it has...everything”**

*Interview 5: Junior Trainee, International Student*

Three out of seven of interviewees inferred that a curriculum could be a double-edged sword, it may create flexible learning, or it could create a structure that is far too rigid to seem productive.

**“The problem with (too much structure) is we all end up being a bit robotic rather than having a bit of freedom to get to grips with the whole subject”**

*Interview 6: Junior Trainee, Home Student*

The majority of participants (5/7) appreciated a multi-disciplinary approach in their training, and felt it enhanced the curriculum and training towards behind a mono-specialist in Endodontics. One participant wanted to explore beyond restorative dentistry even indicating a very broad-based specialist in the making with vast interests.

**“Might be beyond the scope of endodontics but I would have liked to have done a little bit of orthodontics”**

*Interview 4: Junior Trainee, Home Student*

There were 3 rejected codes following final analysis of this theme. One was only relevant to 2/7 participants who wanted to see dental implant placement as part of the curriculum. This was directly contradicted by the 3<sup>rd</sup> Senior trainee, who thought there was an excess of restorative topics - the curriculum should be more 'endodontics' focused.

The relevance of the curriculums to a future overseas job was mentioned, coded and subsequently rejected. Code rejection took place because although this subtheme emerged from the majority of the international overseas students: 2/3 of the participants – the concern towards relevance goes against a much wider picture. While this is definitely a valid concern, overseas funded students will generally only be able to secure funding for a scholarship in a reputable university with a curriculum (and training program) that can be transferrable to their overseas employment model with minimal disturbances and maximum benefits. That way, the scholarship and funding will be justified and be worth the overseas stakeholders' financial investment. Figure 1 is an illustration of the theme and relevant codes.

## **Theme 2: Postgraduates' perception towards their speciality training**

Figure 6 – Theme 2: Postgraduates' perception towards their speciality training

- **Senior and Junior Trainees**
- Strong and demanding course
- Unexpectedly time consuming
  - Paperwork ++
- Research element goes hand-in-hand with clinical speciality training
  - Imperative
  - Increases overall awareness and knowledge
- *Senior trainee:*
  - Feel an adequate broad-base building
  - Appreciate the holistic approach
  - Prefer discussions and feedback
  - Frustrated with hospital inefficiencies

Appreciate the overall 'Restorative' focus

- *Junior trainee:*

Apprehensive about new system

Fear of lacking skills

Insecurity, lack of confidence

Feel an unexpected professional growth

Lack of appreciation towards 'Restorative' focus

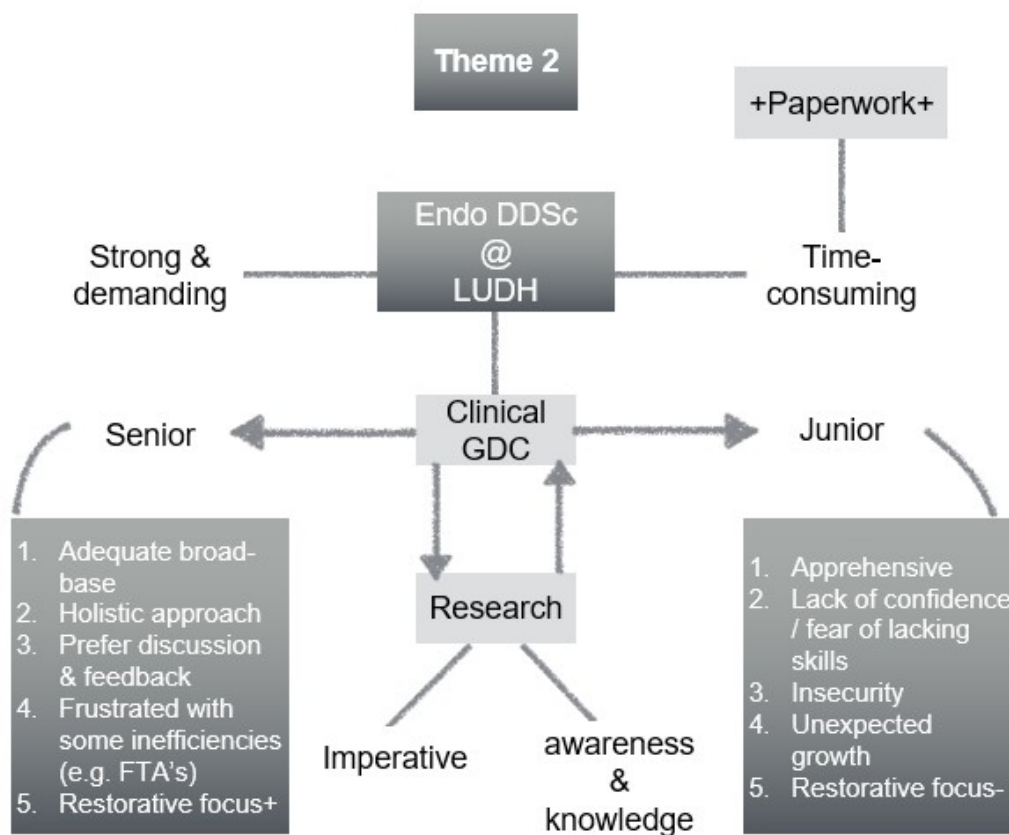


Figure 6 – Theme 2: Postgraduates' perception towards their speciality training

When asked about the speciality training programme thus far, all the participants (100%) were in agreement that the course so far was good but mentally challenging.

**“Our programme follows the GDC curriculum very well and I think it adds to it as well. I think the training we are going through is better**

**than expected”**

*Interview 3: Senior Trainee, Home Student*

**“At this stage, I’m quite happy”**

*Interview 4: Junior Trainee, Home Student*

There was an overwhelming plea regarding the time constraints, the biggest culprit was paperwork associated with tasks such as continuous WBA and the use of the ISCP website. The majority of trainees (6/7) felt the entire paperwork process was unnecessary, unhelpful, and added stress to an already pressurised situation.

**“I think it’s just paperwork (uploaded to the ISCP) website...I can’t see any use at the moment”**

*Interview 7: Junior Trainee, International Student*

**“They should have a different way of doing it...it consumes a lot of time”**

*Interview 1: Senior Trainee, International Student*

There was an awareness of the reciprocal relationship between undertaking research projects and clinical training – and how it has had a direct benefit. Six out of seven of participants felt this part of the training should be maintained. It is perceived to have resulted in their becoming well-rounded specialists with an appreciation and a deeper understanding towards the science behind their practice.

**“It’s not just about conducting your own research but critically appraising other research... research is being created all the time and as a clinician you have to make the decision whether or not you want to adopt that into your own practice”**

*Interview 2: Senior Trainee, Home Student*

Once explored in more depth, differences were found between the 1<sup>st</sup> (Junior) and 2<sup>nd</sup> (Senior) year trainees only. No differences were detected between male vs. female trainees. There were also no differences found when comparing home to international students. There was almost 100% agreement within each subtheme, hence the obvious split between the

stages of training (during the speciality training). Interestingly, only one 1<sup>st</sup> year trainee mentioned the impact of restorative dentistry. Whereas 3/4 only mentioned, and had concerns around, endodontics. Conversely, 100% of the 2<sup>nd</sup> years (Seniors) heavily mentioned restorative dentistry and its direct relevance and importance to endodontics speciality training. Therefore, the 'restorative dentistry appreciation' was rejected for the Junior subtheme list. It was the only rejected code from Theme 2.

**“I think adding more in the way of restorative dentistry into the mix is useful”**

*Interview 2: Senior Trainee, Home Student*

There is a general thirst for discussion-based feedback and an obvious perceived benefit to the overall training.

**“If you have a discussion...and brainstorm...you always get feedback. That’s when you learn”**

*Interview 3: Senior Trainee, Home Student*

All (100%) the 1st year Junior trainees had all encountered unexpected professional growth. The pattern of growth was almost identical from one participant to the other. Starting with apprehension, insecurity and fear of lacking skills. This evolved throughout the first year of training into confidence, security, and conviction with regards to their own patient management and decision making.

**“From the day I came here to now, I am so confident I don’t even refer to my consultants anymore”**

*Interview 5: Junior Trainee, International Student*

**“By the end of this year, I have started to recognise the impact of this system, and this course on my education”**

*Interview 7: Junior Trainee, International Student*

### Theme 3: Postgraduates perception towards work-based assessments

Figure 7 – Theme 3: Postgraduates' Perception towards WBAs

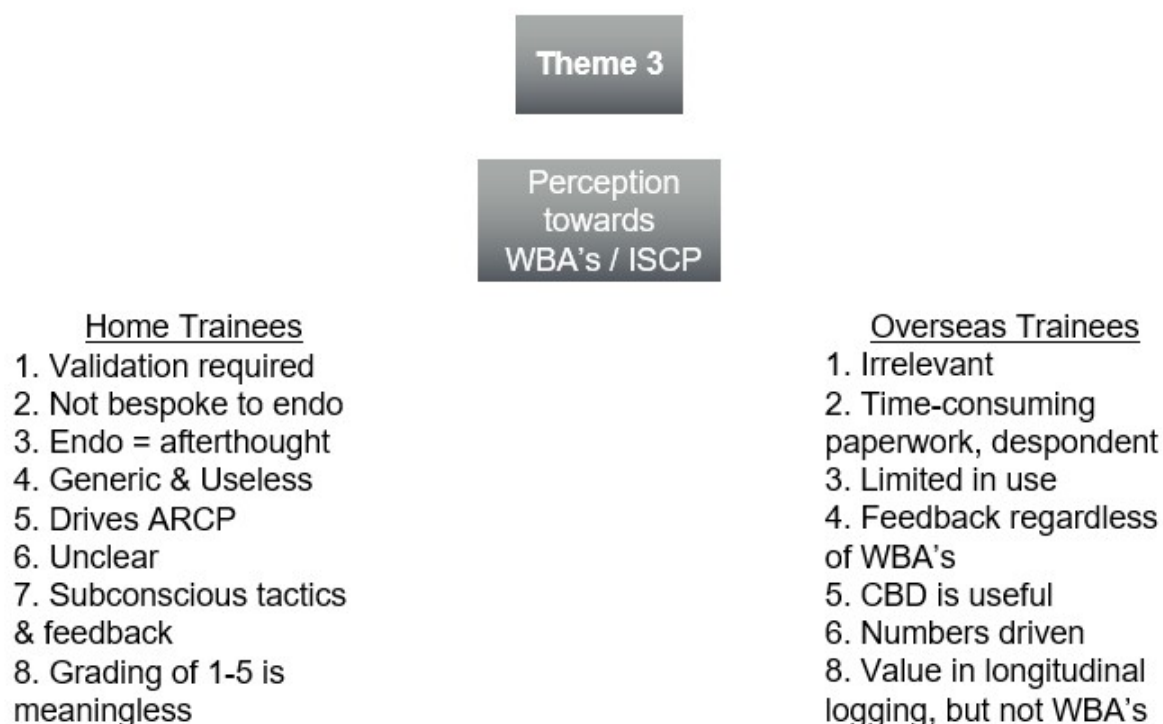


Figure 7 – Theme 3: Postgraduates' Perception towards WBAs

Two distinctive subthemes formed around home trainees vs. overseas trainee perceptions with how they perceived the whole process of WBA. The perception of being subjected to continuous use of WBA's for feedback and training validation was obtained.

#### - **Home Trainees**

Require the validation

WBA forms not related to speciality

Endodontics feels like an afterthought

WBA forms feel generic and useless

The process drives ARCP (Annual Review of Committee Progression)

The process feels unclear

Subconscious tactics take place

Grading of 1-5 is useless

- **Overseas Trainees**

Irrelevant to training

Time-consuming paperwork, despondent attitude

Limited in practical use

Feedback provided regardless of WBA process

Case Base Discussion only one with value

Process is only numbers driven

Value in longitudinal logging, but not WBA's

While all (100%) of the participating home students felt the need for continuous validation via WBA (i.e. paperwork and online logging), they felt the current paperwork lacked serious representation of their training. This resulted in them deflating and losing faith in the process. The process itself turned into a tick-box exercise that was perceived as unhelpful and not relevant to their speciality training of endodontics. This theme carried on and was true for the overseas trainees also but in a more severe form.

**“I really don’t like the WBA’s as they are set up now. I think they have been constructed as an afterthought...some questions are about theatre checks and scrubbing, they haven’t even bothered to change it”**

*Interview 2: Senior Trainee, Home Student*

**“It’s just repetition of paperwork...’form filling’ is quite useless”**

*Interview 6: Junior Trainee, Home Student*

Even though the overseas students felt the need for feedback, the form-filling aspect and the added administrative burden was unhelpful. They also felt feedback was given regardless of WBA, that’s how their teachers worked with them. Some trainees openly expressed their disinterest once the target numbers are reached. As the home students had a meeting at the end of the year with Stakeholders, the motivation behind the task of WBA’s was more fuelled. Unsurprisingly, only to the point of reaching the required number of forms.

**“As soon as I finished them, I stopped caring”**

*Interview 7: Junior Trainee, International Student*

**“After ARCP, I feel like I’ve done it now, and don’t need to do them for a while now”**

*Interview 3: Senior Trainee, Home Student*

These data suggest that the process in place is not driving the right educational habits the stakeholders are hoping for and expecting.

One code emerged from one participated only and was rejected for this theme. It was rejected on the basis that it was contradicting 6/7 of the participants.

**“It is 15 minutes at the end of the session, so it’s not too bad”**

*Interview 4: Junior Trainee, Home Student*

Even in a statement that WBA paperwork isn’t a time-consuming ordeal, the statement included an admittance that the paperwork filling process can in fact take 15 minutes extra at the end of a clinical session.

#### **Theme 4: The Accidental Role Reversal**

Figure 8 - Theme 4: The Accidental Role Reversal

An unexpected finding was the paradigm shift that took place when the postgraduate speciality trainees taught undergraduate dental students. The postgraduate student becomes the teacher in that scenario, and vice versa is true the rest of the time when they themselves are undertaking their training. While giving feedback (as a teacher) and being a recipient of feedback, simultaneously, appear to feed off each other both positively and negatively. The use of LiftUpp (118) was discussed as a model for the current feedback system.

- **As a postgraduate trainee:**
  - The tool has the potential to be very useful
  - PG’s utilise the software to suit their personal need
  - Can add significant time spent on clinics
- **As an undergraduate clinical teacher:**
  - Benefits to digital data collection
  - UG resist feedback



- Sympathy /other emotions impacts feedback given
- Teachers aware of optimised student tactics / behaviours

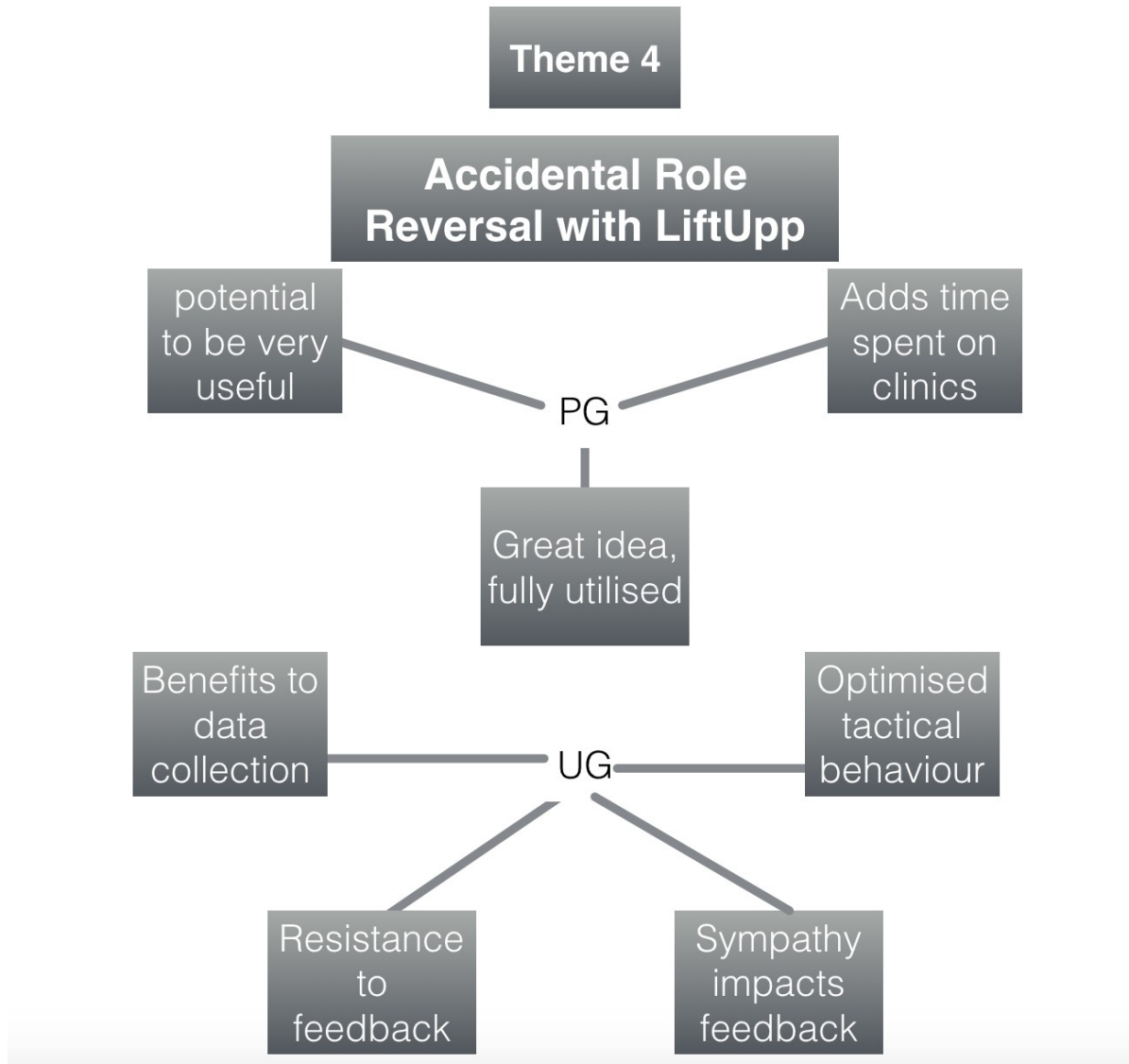


Figure 8 - Theme 4: The Accidental Role Reversal

All (100%) of participants agreed that using LiftUp as an undergraduate tool was valuable, especially when some make direct comparison to the undergraduate training they received.

**“I think it’s really good that everything is tracked”**

*Interview 6: Junior Trainee, Home Student*

Some see enormous benefits to data collection to ease monitoring students and be able to help those who really need more attention, since the application itself breaks down a procedure into many multiple steps, it has the ability to detect specific issues.

**“I think it is a very good idea for undergrad (endo) training. It shows their whole progress...what they are capable of, what they are not.”**

*Interview 1: Senior Trainee, International Student*

**“There are some things you tend to forget like record keeping, time efficiency...and then you start remembering because you know you need to give (the students) feedback”**

*Interview 3: Senior Trainee, Home Student*

All the participants have noticed tactics and ‘optimised behaviours’ when undergraduate dental students are concerned, with even some resistance to honest and helpful feedback. There appears to be a misunderstanding behind the whole initiative of a continuous feedback system.

**“Students should be aware, it’s not a grade and it’s not a mark. It’s development! They still treat it as a mark”**

*Interview 5: Junior Trainee, International Student*

**“Students are intelligent people who optimised their behaviour to maximise the development indicators”**

*Interview 2: Senior Trainee, Home Student*

Some trainees could not help but get emotionally sympathetic with the students. This is due to the ‘closeness to home’ element. Every single specialist in training was an undergraduate student in the last decade. Personal experiences have played a role in the quality of feedback due to sympathy, as well as empathy.

**“Sometimes, everything should be a grade down, but it’s a hassle because the students get disappointed and question...they are very scared”**

*Interview 6: Junior Trainee, Home Student*

When considering their use of the LiftUpp model for their own training, the postgraduates all agreed that it is useful. There was an inference of added maturity when a postgraduate decides to undergo further training. Therefore, a better acceptance towards feedback and low development indicators on LiftUpp are seen as an opportunity for improvement and self-regulating. Some postgraduates appear to have adapted the use of the app (beyond the norm) to suit their own personal need. Their self-motivation is at such a high level where they can see past an apps basic functionality. Trying to maximise the benefits and streamlining a few processes at once to enhance their own training and personal experience.

**“I’ve now started logging in what information I am (clinically) doing, what working length...what file system I used...what sealant I used. It’s absolutely making my training easier”**

*Interview 3: Senior Trainee, Home Student*

## Discussion

It is important to acknowledge and highlight the perceived bias created by this type of research. Interviews generally rely heavily on the researcher’s personality traits, as well as the participants’ personality traits. The availability of different participants could undoubtedly the result in different codes and themes. It is uncertain whether this would impact upon the conclusion, also. The phrase ‘perceived bias’ is used here to describe this situation because this ‘bias’ is technically unavoidable. The researcher cannot help but become immersed in the research, and therefore, becomes an inevitable subject within the experiment. The beauty of this type of research is how the researcher interprets and reports on the data collected.

### Main findings (Theme 1 and 2)

While the sample size of this project is small, the aim of this type of qualitative research methodology, including thematic analysis, is to attempt to reach data saturation. Data saturation is defined as *reaching a point when there is enough information to replicate the study when the ability to obtain additional new information has been attained, and when further coding is no longer feasible* (119). It is a grey area and there is no consensus on how to reach saturation, or the number or participants needed to reach data saturation. Mason (116) reported on the conundrum - While some researchers suggest 20 participants to ensure data saturation, others say ‘less than 50 participants’, which is a huge discrepancy between what is deemed as an acceptable sample size. Others, suggested that researchers (especially ones limited by time) do not have the luxury of continuing the sort of open-ended research that true data saturation requires (116). It is a convincing concept, with practical weaknesses.

In the case of this project, there were only 7 potential participants. A contingency plan, set aside, was to reach out to other UK Universities with similar speciality training to Liverpool University. Data saturation, based on definition, was in fact reached after completion of seven interviews, and the initial aims set out were achieved. The areas could be explored in full depth and there were unforeseen topics like Theme 4 – the Role Reversal.

A curriculum has been defined as ‘a planned learning experience’ (120). Materials presented in a logical order have been shown to be easier to learn (121), which indeed is in line with how the postgraduates perceived the GDC curriculum. All the participants appreciated the availability of the document, how it’s sensibility worded and presented. Thematic analysis in this case highlighted the need for an available curriculum as a reference. But, it ideally should allow for flexibility in learning, and possibly further enhance the need and necessity of multi-disciplinary dentistry. The current curriculum that the GDC provide is a well-known, highly regarded document. The continued availability of an extensive curriculum for endodontic specialist training in the UK is therefore supported based on the findings of this study.

Our data identified the importance of acknowledging high workloads and the deleterious impact of an abundance of administrative tasks. A situation that appears to negatively impact on trainee’s educational journey and wellbeing. The trainees are struggling with the current laborious process, and perceived it as an ‘unnecessary repetition’ of the same administrative tasks. While all the trainees admit that the specialist training course is overwhelmingly demanding, personal wellbeing must be addressed, and attempts should be made to improve this aspect. Quality of life may indeed impact on trainees productivity (122), which may have much worse repercussions when trying to reinforce the traits of a lifelong learner. Lazarus’ Transactional Model of Stress and Coping remains relevant to these particular codes (2.1 and 2.2). According to this model (123), many of the events that compromise the experience of life (illness, loss, trauma, new job) can be considered ‘stressors’. In the absence of the resources needed to cope with and manage these stressors, people experience their effects in the form of reduced mental – and to a lesser extend physical – health. The World Health Organisation (WHO) reported in ‘The World Health Report’ in 2013 (124) that mental health places major constraints on the well-being, productivity, and prosperity of individuals, communities and nations. Perhaps a level of resilience is needed to undertake such a demanding course. Our data suggests that perhaps the Junior trainees are building resilience during their ‘unexpected growth’, whereas the Senior trainees have developed that required resilient thick skin already.

Although the term ‘resilience’ has been used in many disciplines, and applied to many contexts, a recent analysis defined resilience as the *‘process of effectively negotiating, adapting to, or managing significant sources of stress or trauma’* (125). That is, the ability of individuals to adsorb life’s challenges and to carry on and persevere in the face of adversity (126). Data suggests that resilience is a modifiable construct and not an inherent, immovable trait of individuals (127). There doesn’t appear to be an efficacious method of achieving resilience in people yet. However, resilience and confidence have a closely intertwined relationship. Additionally, it is well established that confidence is linked to self-efficacy, which in turn is linked to goal setting. Moreover, there are established ways of building self-efficacy, which would have a positive impact on reflection and help support deliberate practice and ultimately change to self-regulation, the pivotal step in learning.

Our data also shows how positively the trainees responded to partaking in their own research project, and other elements of the course such as participation in hospital audits and weekly journal clubs. These elements are all perceived to be greatly beneficial to their speciality training. The relationship appears to have bidirectional benefits, one further enhances the other. The ability to probe and explore peer reviewed published research, in the field of endodontics, has given a deeper and more profound understanding towards their own clinical work. Therefore, these aspects should be further enhanced, and encouraged. Reflection and feedback should be embedded in every aspect of the training to allow the traits to become second nature to the trainee. This will ensure lifelong learners are the end product of the training.

### **Work-based assessments (Theme 3)**

WBA’s were introduced into speciality training programmes coupled to a website (for recording data) that had to be used in tandem. The website was called the Intercollegiate Surgical Curriculum Programme (ISCP) and is currently mandatory for all UK specialty registrars, in particular the ten surgical specialties and a number of dental surgical specialties. Most specialties initially resisted the change, and were all extremely dissatisfied (128).

Using the online tool enabled the registrars to create an online log of all the required WBA’s, therefore ticking off a large component of the postgraduate training. Using the ISCP website enables the successful registrars to be awarded a Certificate of Completion of Training

(CCT). Membership to the site comes at a compulsory fee of £125.00. However, in a survey that aimed to evaluate user satisfaction, 49% described its online assessment as poor or very poor, and only 9% considered it good or very good (128) after a year of experience. These misgivings are certainly supported by our data which showed the same dissatisfaction for endodontic speciality trainees, who do not see the forms as relevant to what they do clinically.

Developers have worked hard to constantly improve the services provided by the ISCP websites (129), however, the WBA forms remain totally irrelevant to endodontic specialty training. Although having a perfectly efficient online log will (in theory) ease user process and experience, it still does not eliminate the concerns revolving around competency-based training itself. If the process is applied inappropriately, it can result in an increase in administrative burden, a focus on minimum acceptable standards and demotivation (130). Our data supports this, as all the trainees commented that the process is driven by numbers which seems like the only motivation. Any benefits perceived by the process of WBA's like feedback and open discussions are experienced by the trainees with or without WBA's, from the teaching staff.

One of the main issues of the current practice is highlighted by data from the three year follow up with ISCP users also highlighted most assessments were still filled out in batches in 1 sitting by trainers as an overall impression of the trainee (131), rather than related to individual cases. In these instances, the WBA is not serving its purpose of being a platform for reflective focus and longitudinal development. Rather, these data suggest that trainers and trainees regard the WBA process as a task and not integrated to the educational process. A notion that is further supported by the GMC's Key Findings from the National Training Survey (2010). Data demonstrated that up to 80% of consultants registered with the GMC claimed they score their trainers WBA's retrospectively, which does not represent a true individual reflection. Furthermore, over 15% of consultants in that same report have turned down trainees' requests for WBA's because of work pressures. This worrying situation is further complicated by poor calibration between assessors which highlights the need for staff training to ensure consistency in how these tasks are performed. The quality of feedback, when WBA's are done retrospectively, is likely to have a direct impact on the learning cycle. However, it is encouraging to note that for WBA's used in Dental Foundation Training (DFT) within the Mersey Deanery in 2009, data show approximately 80% of the trainees

claimed the feedback was provided in a supportive way, which gave insight into their own development needs and improved confidence (132). These data show that when used appropriately and informally, WBA can have the expected positive educational impact.

At Liverpool University Dental Hospital (LUDH), a new integrated way of using WBA principles has been developed that enables the rapid collection and integration of daily data across all clinical contexts to establish a detailed understanding and provide personalised feedback over the longitudinal performance of the trainee across all domains. The system is known as LiftUpp. LiftUpp is an innovative technology supported educational tool aimed at improving curriculum management, student performance and the student experience with a reduced administrative workload. The tool was designed to improve the student experience through personalised education to ensure all aspects of the curriculum of study are taught and appropriately assessed; to produce detailed personal portfolios that enhance employability; and to enable the continuous assessment of non-technical skills such as communication and professionalism.

LiftUpp has enormous potential to streamline many different aspects of postgraduate education. Although the data suggest support for its use, the full potential of LiftUpp in this arena is yet to be determined.

#### **The Role Reversal (Theme 4)**

Peer Assisted Learning (PAL) has occurred informally in medical education for many years (133). There has been much said about the use of PAL and the associated cognitive, pedagogical, attitudinal, social and economic benefits associated with utilising peer tutors. Our data supports that this fact remains true in the context of endodontic postgraduate trainees teaching undergraduate dental students. PAL has been shown to be perceived as beneficial by trainees (134), which aligns to our data.

Cate and Durning presented 12 reasons that support PAL, as well as three distinct dimensions that may be used to describe teaching activities that rely on PAL (135). The first is the educational distance between student tutor and tutee. A safe assumption to make would be that postgraduates are closer to undergraduates compared to consultants and more senior staff members. The competence gap is closer and therefore, students may be more likely to take in new knowledge and engage in a dialogue which will aid in enabling the different elements of the learning cycle (136). The second dimension of PAL is the formality of the educational

setting, and the third dimension of PAL is the learner group size. A summary is provided in Table 9 - Cate and Durnings 12 reasons to support PAL.

<b>Cate and Durnings 12 reasons to support PAL</b>	
1	To alleviate teaching pressure for faculty
2	To offer education to students on their own cognitive level
3	To create a comfortable and safe educational environment
4	To socialise students in medical school and provide role models
5	To offer students an alternative motivation as well as another method for studying
6	To enhance intrinsic motivation in students
7	To prepare physicians for their future role as educators
8	To practice peer feedback as part of multi-source feedback
9	To train leadership skills and confidence
10	To sustain medical training programmes in severely resource-constrained settings
11	To modify the academic medical culture toward embracing education as a core task of healthcare
<b>12</b>	<b>To offer supervision responsibility to trainees in competency-based postgraduate programmes</b>

*Table 9 - Cate and Durnings 12 reasons to support PAL*

At LUDH the group sizes average at 4 undergraduate students to 1 postgraduate. The setting takes part on clinics with real patients, so can be considered as formal. The postgraduates compared the undergraduates they teach to their own previous undergraduate experience. What emerged from the data was that there appears to be both benefits and disadvantages. With two of the codes emerging under this theme as ‘Sympathy impacts feedback’, and ‘Students resist feedback’ – both of which could have a huge bearing on the learning cycle and the aim of producing a lifelong learner, and align with previous observations that highlight the issues around ‘failing to fail’ (137).

Other issues surrounding the use of PAL include the potential increase in tutor or teachers’ workloads, especially worsened when considering the already huge workload demonstrated



by the emerging codes in Theme 2. However, the institution could also benefit greatly by the processes due ability to alleviate teaching pressures for faculty (135). Table 10 – The benefits and potential drawbacks of PAL (138) is taken from a very recent overview of PAL in medical education.

	PAL Tutors			PAL Tutees		
	<i>Learning Benefits</i>	<i>Developmental Benefits</i>	<i>Outcome Benefits</i>	<i>Learning Benefits</i>	<i>Developmental Benefits</i>	<i>Outcome Benefits</i>
<b>Positive Effects</b>	Enhanced knowledge acquisition and retention	Self confidence booster	Improved examination performance	Better understanding of difficulties	Contact with official and ‘hidden’ curriculum	Improved academic performance
		Ability to admit uncertainty		Eased learning processes	Deeper learning process	
	Better learners’ due to better underlying understanding	Helpful for future job applications	Better communication skills	Better assessment of existing knowledge	Familiarisation with the new environment	
<b>Potential Drawbacks</b>	Less contact with experts	Less contact with experts				Reduced academic performance

*Table 10 – The benefits and potential drawbacks of PAL*

Peer assisted learning in the context of endodontic speciality training appears to be perceived as extremely beneficial by the postgraduates. It therefore, should be maintained and improved upon, but only after exploring ways to ensure consistent feedback delivery to undergraduates.

## Conclusions

Postgraduates training in endodontic speciality seem mostly satisfied with the journey thus far, albeit a demanding and challenging one. Some areas of the postgraduate training such as undertaking a research project and PAL are perceived to be highly beneficial. Conversely, WBA's are driving the wrong educational impact and are not currently perceived as relevant to postgraduates training. Some thought needs to be placed on the current implementation of endodontic teaching and assessment, while taking into account the psychosocial development, in order to reduce time restraint pressures and administrative burdens.

## Chapter 5: The Final Chapter

Our data has given us an understanding of the level of endodontic training for current UK Dental school graduates. Although the mapping exercise of GDC ILOs did demonstrate parts of endodontology that could be considered to be the endodontic knowledge and skills baseline level of current dental school graduates, the survey data demonstrated that the way ILOs are being met is far from consistent due to the way endodontic teaching and assessment is being varied throughout the UK. Moreover, this variability can extend to the expectations of each trainee within a single dental school. Furthermore, there is still little evidence to support that the current assessment approaches undertaken have sufficient utility (139) to establish competency or effectively drive the learning cycle to ensure changes to self-regulation (Figure 1 – The Learning Cycle). This will likely have a very different endodontic educational impact (86) between undergraduates qualifying to become registered general dental practitioners. Furthermore, there is little evidence that the growing problem of learners with fixed mindsets is being addressed. Rather the data suggests it is being perpetuated through stand-alone assessment strategies, numbers of teeth to complete, and reflective practices operationalised as tasks to complete. The undergraduate end result will likely have repercussions, and compound the difficulty for a postgraduate course trying to create specialists.

The GDC undergraduate ILOs that mapped to similar postgraduate ILOs (Table 2 – Similar Intended Learning Outcomes) could be summed up into 2 main items which were described in Chapter 2 conclusion i.e. *Having a wide breadth of dental examination and endodontic diagnostic skills*, along with *the ability to be considered a 'safe beginner' in performing uncomplicated deciduous and permanent endodontic treatment*. These ILOs may not be met to their fullest potential due to the serious lack of suitable cases. Furthermore, it is debatable whether or not contingency plans set up by the Dental Schools (e.g. offer simulation as an alternative) have any sort of positive impact on their endodontic education. In fact, without appropriate feedback, simulation (as a contingency plan) could provide students with a negative teaching experience. Moreover, the quality of knowledge imparted to undergraduates in terms of the prognosis of endodontic treatment, treatment options, and alternatives such as endodontic surgery and root canal re-treatment was not established in our survey. Therefore, the quality and level of knowledge imparted to undergraduates in these important areas variable and largely remains unknown. In view of these data, a safe

assumption to make for the starting point of postgraduate education in endodontics would be, at best- *limited experience in endodontics*, making postgraduate speciality training congested during the allotted three-year period.

Our data from Chapter 4: The Interviews shows that the current postgraduates at University of Liverpool did not perceive their previous undergraduate training as a hindrance during their speciality training. This is interesting because there was such high level of agreement over the demanding nature of the speciality training program, which could likely be partly attributed to gaps in their previous undergraduate training. Even though the endodontic clinical skills at hand may initially be at a high, proficient standard (especially if endodontics is being performed regularly prior to commencement of postgraduate training), the deep specialist level knowledge may still substantially lack. So, one cannot help but wonder if their perception of postgraduate training would still be perceived as ‘tough’, had their undergraduate training been more consistent, and at an appropriate level?

Our data highlighted that one of the current perceived strengths of the postgraduate training was that clinical training and research had reciprocal benefits. The ILO regarding performing a hospital audit was definitely perceived as an enhancement to the speciality training programme. This relationship between research and clinical should certainly be maintained and considered an integral part, as the trainees perceived the benefits both clinically and professionally. Moreover, performing their own research project, and critically appraising peer reviewed published research, seems to have had a positive educational impact through giving the trainees a deeper understanding of their own clinical work. This was obvious from the respondents’ answers, which are quoted in Chapter 4’s Results.

Another positive finding was that all the postgraduates appear to be building confidence and resilience as the training progresses. An observation supported by data that suggested that they are all aware of personal growth, in particular, the junior trainees who have been training just under one year. This is a significant finding with respect to the learning cycle and further work is needed to understand the factors in detail that contribute and detract from this.

The data also suggested that WBAs were not being universally perceived as being beneficial. Even though WBAs do have a large following of believers who have been researching their feasibility and application for 10 years (140), the fact remains that their use and

implementation is often far from what the stakeholders anticipated. Due to work pressures, convenience, and learner mindset, these reflective tools are often trivialised and become nothing more than a tick box task by both student and staff alike (50). In addition, our thematic analysis and emerging codes, indicated further barriers to the WBA driven reflective process due to the repeating multiple administrative steps which do not necessarily apply to their endodontic practice on clinic. Unfortunately, our data shows that the way WBA's are currently perceived and operationalised appears to seriously limit their utility.

Having established many difficulties, it is incumbent on the researchers to consider how the current education model could be improved upon and developed to enhance the postgraduate trainees learning experience and the associated development in capability (53). Innovative ways to alter parts of the training must be considered in order to achieve capable professional specialists through exploring how to: (a) reduce current time restraints and pressures; (b) utilise that time to enhance areas perceived to be beneficial, and perhaps most important of all, (c) consider the trainees psycho-social development.

A challenging part of implementing a learning cycle is the psycho-social development that is needed to support it because a large portion of successfully completing the learning cycle needs to come internally from the trainee. A trainee with a fixed mindset will not be able to grow from feedback (64) and reflection (103), and consider any failure...*a failure of one's self*, rather than a learning opportunity to afford future success (58). Therefore, there is a definite need for a post graduate programme of study to ensure consistent and active development of psychosocial skills (141), especially as the basis of self-reflection is the ability to act on and respond to criticism from others, as well as the ability to self-criticise and grow as a lifelong learner.

## Reflection and Feedback

A crucial question is, 'how is reflection developed'? Data suggest that with some guidance, it is possible to engage with and develop effective self-reflective practice (142), however this is intimately linked with the self-efficacy and goal setting ability of the learner (143), as well as

the quality of the feedback given (62, 64). Therefore, staff need to be trained in feedback delivery as much as students do in reflection and action.

A problem-based learning (PBL) is attractive for this purpose because it is learner centred and data has shown that it can be used to develop a variety of skills, such as teamwork, problem formulation, information finding, discussion and explanation of new information to others, decision making, and conclusion formulation (144, 145). All of which could contribute greatly to the development of a reflective learning, if guided in the right way. According to a recent systematic review (146), PBL positively affected the perceived preparedness of students. In addition, it is likely that some form of psychosocial testing with respect to current levels of self-efficacy and resilience would be beneficial to provide the reflective focus over the current level of personal need for the student to develop the psychosocial skills that are essential to support effective learning.

Feedback takes place currently using Royal College of Surgeons (Edinburgh) compulsory WBA's. Our data strongly suggest that current methods of WBA's are not driving the right behaviour, and not having a totally positive impact on the postgraduates' education. It is seen by the trainees as a tick box task, obtaining numbers for a deadline, rather than the intended purpose of a focus for reflection, and ongoing, learning. The only WBA that was perceived to be useful was CBD, which involves a lot of discussion, whether its group or 1 on1, on certain cases, and the process involves feedback and reflection. Further work, is needed to understand why this particular tool seems to have some positive impact while the others do not. Overall, our findings over the potentially negative impact of WBAs are not unsurprising and consistent with other published data. For example, in a systematic review where sixteen studies were included, Miller et al, stated that there is no evidence that alternative workplace based assessment tools (mini-clinical evaluation exercise, direct observation of procedural skills, and case based discussion) lead to improvement in performance, although subjective reports on their educational impact are positive (147). This aligns perfectly to our findings, as the trainees do perceive some benefit from the process of WBA's, however, not the way they are currently implemented. It would seem the solution to the first major issue would be to suggest and trial different ways in which WBA's could be differently implemented, all the while considering their impact on self-reflection, and ongoing deliberate practice (55), as well as gaining trainee insight. Alongside such changes, there is also a need for the trainee to

fully understand the purpose of WBAs and be encouraged them to be used as a mechanism to support the learning cycle rather than a task to complete.

A good starting point to make change is to reflect on the reductionist nature of WBAs i.e. a WBA reduces complex data and phenomena to simple list of terms and observations, which are scored on a scale of 1-5. However, a real-world activity is considerably more complex and requires multidimensional skills and knowledge to be used and integrated simultaneously. Entrustable Professional Activities (EPA's) recognise this complexity and were introduced to address it. EPAs comprise real-world clinical tasks that trainees can be trusted to perform with minimal or no supervision (148). EPAs can be based on the Canadian Medical Education Directions for Specialists (CanMEDS) framework which defines competencies a physician should attain summarised in seven roles: medical expert (the central role), communicator, collaborator, manager, health advocate, scholar and professional (149). Not the time spent in training is the important outcome measure but rather the attainment of competence. As each EPA defines a real professional activity that can be entrusted to a trainee and as each EPA is linked to several competencies which are most crucial to a specific EPA schools tend to follow the suggestion by Mulder et al. (150) to refer to the seven CanMEDS roles as 'domains of competence' (151). It would be wise to consider either changing the way currently WBA's are implemented, and / or consider injecting EPA's into the training also because this would fulfil suggestions that the assessment needs to be sufficiently sophisticated to measure capability and therefore have the correct utility to drive reflection (Figure 1 – The Learning Cycle). Further work is needed to establish the best interventions for this purpose.

## Teaching

Teaching specialist level endodontic skills to a wide variability within our new intake of postgraduates could be a cause for concern. Our survey demonstrated large differences in the teaching and assessment methods, within the UK undergraduate graduate population. Postgraduate courses are usually a mix of UK graduated students and overseas students, so the variation established in our study is likely only the 'tip of the iceberg'. The foundations of competency in endodontics are established in undergraduate training and enhanced further with work experience. This variability is magnified further when considering the general

Dentist's work experience and other factors which may factor into the overall clinical skills acquired. Unless both the academic establishment and trainee are aware of the clinical and psychosocial skills at hand from the start, milestones and goals cannot realistically be set. Establishing such milestones and psychosocial level will require sophisticated and complex approaches that must include real-world situations so that their integrated use of competencies and abilities to reflective can be established (52). To achieve such demands will require the ability to longitudinally monitor clinical activity and the learner response to feedback. LiftUpp (118) would provide a suitable platform to achieve this, and the data collected could then inform personalised interventions for each trainee. This would be a suitable solution, and for most trainees, issues could be efficiently addressed within the time period of the training. However, if significant issues were found, a suitable approach could include *booster summer courses* for core endodontic skills. The time frame of the booster summer training – 'Pre-Specialisation' could depend largely on what needs to be achieved, with the aim of the academic establishment being to ensure postgraduate trainees are meeting undergraduate ILOs consistently by the end of the booster course. Depending on how vast the variability is, this could be a simple three-day course or an intensive multiple week training. Such interventions would potentially ensure both home students and international students are all given a fair starting point. This period could include both clinical training, as well as reinforcement of the learning cycle elements including the theory behind feedback and reflection. Another way to reduce the initial variability would be to utilise the first few weeks of training to implement a 'Pre-Specialisation' period. The only downfall of that would be further congesting an already overloaded three-year training program. Whether or not these suggestions will reduce variability could only be established once 'Pre-specialisation' is trialled and reviewed. In addition, such approaches could also include simulation and the use of phantom heads (discussed in Chapter 3 – the Survey). Even considering the faults, it is likely simulation could still be used effectively in the 'Pre-specialisation' period, supporting the bulk of the training that should be undertaken on real patients.



## Final Thoughts

The data suggest that, to tackle the problems at hand, there is a need for change in the way we develop our specialists in endodontics. While there are many issues with the current structure and implementation of training, there are many positive aspects. However, available data suggest that unthoughtful solutions may result in the same, or different, types of negative behaviour, which would directly oppose any of the thought process behind innovative and better ways to train. This is because competitive students, with a fixed mindset, try to game the learning cycle by jumping crucial steps and creating shortcuts for short lived glory. A situation that is a detriment to the healthcare profession and likely leads to patient harm (152). In an ideal world, educators would inspire students to be open and honest and want to learn from mistakes, such notions must be embraced in the ideal training programme.

The first phase of the change in process must be achieving a consistent baseline. To do this the educational establishments need to take into consideration two important aspects about their new specialists in training. This first aspect is what the trainees can do clinically from the offset i.e. their current clinical base-line, and the second, is understanding any current barriers to learning that the trainee has. In the longer term, achieving broader consistency amongst new qualified general dental practitioners should take place by developing the ideal undergraduate curriculum which would consolidate teaching approaches nationally.

To establish the current base-line consideration could be given to creating a 'pre-specialisation' period. Such a period of clinical training *must* be supported by developing psychosocial skill including thoughtful reflection and feedback. This skill development can be facilitated by making trainees aware of the learning cycle and evidence behind each step of the cycle, so that they can then actively work on being a lifelong learner from the start. The pre-specialisation period should be operationalised in a flexible manner, due to the unknown nature in variation at hand, and establish the current level of skill and ability to develop. For those trainees whose current baseline is appropriate their 'pre-specialisation' period can be utilised through introducing them to peer assisted learning so that they can better understand their current skills and develop them in their colleagues. This ideal situation would ensure every new trainee learns at their own appropriate pace and level. By the end of

the pre-specialisation period, all trainees would be minimally fulfilling undergraduate ILO's consistently. These ILO's include correct endodontic diagnosis, treatment planning, as well as treating uncomplicated deciduous and permanent dentition (See Chapter 2: The Mapping).

The second phase of change would build on the undergraduate ILOs and psychosocial skills to begin the development of specialist level skills through regular feedback, deliberate practice and reflection. Traditional lectures and PBL have both been previously discussed as similar and relatively equal in the delivery of information to students. Therefore, they could and should both be utilised in endodontic teaching. Simulation in a phantom head laboratory could certainly supplement the clinical training, however, should never be favoured over real life experience with real patients as dental simulation still lacks seriously utility (91, 94).

Even though training is currently technically taking place with ample feedback and reflection, our data established that the current approach is not always driving the right behaviours needed for lifelong learners. Therefore, the development of skills led by teaching staff members must constantly refer to the learning cycle by having a psychosocial element with a mentoring approach. In order to achieve that, staff and students need to understand elements of the learning cycle. Conventional WBA's might still be the perfect tool for the required early development of specialist level clinical skills, even though they were criticised for being reductionist in their approach and students saw them as a task. This is because if used appropriately data suggest WBA's are able to identify issues and allow staff to provide focused mentoring advice (50). However, after the first year of training a switch from strictly WBA, to a mix of EPA (148) and WBA should take place, to support the learner developing real-world skills and establish trust which will likely build self-efficacy. In parallel to this there is a continuous need to reinforce psychosocial elements with the end-result of being a lifelong learner in mind.

To operationalise the process of longitudinally monitoring the clinical activity of trainees requires an appropriate platform. In the early stages the platform needs to support an externally guided staff driven activity. However, as the learner develops, this needs to transition to an internally driven process, led and directed by the trainee. The use of a platform such as LiftUpp (118) could be used to establish the baseline at the start as well as provide feedback during the entirety of the speciality training. Moreover, LiftUpp could also be adapted to allow the transition from a staff lead to trainee led feedback process through establishing 'a level of trust' and allowing the trainee to make decisions about their own

performance that are initially externally confirmed until eventually the trainee is trusted as a specialist. This final phase is all about the change and evolution that will show the growth of a taught learner to a self-directed learner. Creating a specialist who is demonstrably making the right decisions by themselves.

## Final Conclusions

1. Consider addressing variability in a formal setting through a pre-specialisation period where trainees are introduced to the learning cycle elements
2. Utilise simulation labs, clinical sessions, lectures and PBL methods of learning for endodontic knowledge and skill
3. Train staff and postgraduates how to reflect, and give / receive feedback / set goals regularly by using LiftUpp, WBA's and EPA's.
4. Elements to be maintained and enhanced: research component, audits, peer assisted learning, longitudinal monitoring.
5. Continuously monitor postgraduate trainee's opinions to ensure positive changes to the training are occurring

## References

1. Braun V, Clarke V. Using thematic analysis in psychology. *Qualitative Research in Psychology*. 2006;3(2):77-101.
2. Kenneth Hargreaves LB. *Cohen's Pathways of the Pulp*. 11th ed. 2015.
3. Gulabivala K, Ahlquist M, Cunningham S, Gambarini G, Tamse A, Bergenholtz G, et al. Accreditation of postgraduate speciality training programmes in Endodontology. Minimum criteria for training Specialists in Endodontology within Europe. *International Endodontic Journal*. 2010;43(9):725-37.
4. Chambers DW, Gerrow JD. Manual for developing and formatting competency statements. *Journal of Dental Education*. 1994;58(5):361-6.
5. Pashley DH. Dynamics of the Pulpo-Dentin Complex. *Critical Reviews in Oral Biology & Medicine*. 1996;7(2):104-33.
6. Pashley DH. How can sensitive dentine become hypersensitive and can it be reversed? *Journal of Dentistry*. 2013;41(0 4):S49-55.
7. Matthews B, Vongsavan N. Interactions between neural and hydrodynamic mechanisms in dentine and pulp. *Archives of Oral Biology*. 1994;39 Suppl:87s-95s.
8. Abbott PV, Yu C. A clinical classification of the status of the pulp and the root canal system. *Australian Dental Journal*. 2007;52(1 Suppl):S17-31.
9. Brannstrom M. Sensitivity of dentine. *Oral Surgery, Oral Medicine, and Oral Pathology*. 1966;21(4):517-26.
10. Carrotte P. Endodontics: Part 3. Treatment of endodontic emergencies. *British Dental Journal*. 2004;197(6):299-305.
11. Estrela C, Guedes OA, Silva JA, Leles CR, Estrela CR, Pecora JD. Diagnostic and clinical factors associated with pulpal and periapical pain. *Brazilian Dental Journal*. 2011;22(4):306-11.
12. Mehrvarzfar P, Abbott PV, Saghiri MA, Delvarani A, Asgar K, Lotfi M, et al. Effects of three oral analgesics on postoperative pain following root canal preparation: a controlled clinical trial. *International Endodontic Journal*. 2012;45(1):76-82.
13. Bergmans L, Van Cleynenbreugel J, Wevers M, Lambrechts P. A methodology for quantitative evaluation of root canal instrumentation using microcomputed tomography. *International Endodontic Journal*. 2001;34(5):390-8.

14. Parashos P, Gordon I, Messer HH. Factors influencing defects of rotary nickel-titanium endodontic instruments after clinical use. *Journal of Endodontics*. 2004;30(10):722-5.
15. Mozayeni MA, Golshah A, Nik Kerdar N. A Survey on NiTi Rotary Instruments Usage by Endodontists and General Dentist in Tehran. *Iranian Endodontic Journal*. 2011;6(4):168-75.
16. Higuera O, Plotino G, Tocci L, Carrillo G, Gambarini G, Jaramillo DE. Cyclic fatigue resistance of 3 different nickel-titanium reciprocating instruments in artificial canals. *Journal of Endodontics*. 2015;41(6):913-5.
17. Inan U, Aydin C. Comparison of cyclic fatigue resistance of three different rotary nickel-titanium instruments designed for retreatment. *Journal of Endodontics*. 2012;38(1):108-11.
18. Salehrabi R, Rotstein I. Endodontic treatment outcomes in a large patient population in the USA: an epidemiological study. *Journal of Endodontics*. 2004;30(12):846-50.
19. Ng YL, Mann V, Rahbaran S, Lewsey J, Gulabivala K. Outcome of primary root canal treatment: systematic review of the literature -- Part 2. Influence of clinical factors. *International Endodontic Journal*. 2008;41(1):6-31.
20. Ng YL, Mann V, Gulabivala K. A prospective study of the factors affecting outcomes of nonsurgical root canal treatment: part 1: periapical health. *International Endodontic Journal*. 2011;44(7):583-609.
21. Ray HA, Trope M. Periapical status of endodontically treated teeth in relation to the technical quality of the root filling and the coronal restoration. *International Endodontic Journal*. 1995;28(1):12-8.
22. Ng YL, Mann V, Gulabivala K. A prospective study of the factors affecting outcomes of non-surgical root canal treatment: part 2: tooth survival. *International Endodontic Journal*. 2011;44(7):610-25.
23. Ng YL, Mann V, Gulabivala K. Outcome of secondary root canal treatment: a systematic review of the literature. *International Endodontic Journal*. 2008;41(12):1026-46.
24. Haapasalo M, Shen Y, Qian W, Gao Y. Irrigation in endodontics. *Dental Clinics of North America*. 2010;54(2):291-312.
25. Haapasalo M, Shen Y, Wang Z, Gao Y. Irrigation in endodontics. *British Dental Journal*. 2014;216(6):299-303.
26. Carrotte P. Endodontics: Part 6. Rubber dam and access cavities. *British Dental Journal*. 2004;197(9):527-34.

27. Friedman S, Mor C. The success of endodontic therapy--healing and functionality. *Journal of the California Dental Association*. 2004;32(6):493-503.
28. The National Health Statistic 2015 [Available from: <https://www.gov.uk/government/statistics>]. Accessed October 2017.
29. Qualtrough AJ, Mannocci F. Endodontics and the older patient. *Dental Update*. 2011;38(8):559-62, 64-6.
30. Shay K. The evolving impact of aging America on dental practice. *The Journal of Contemporary Dental Practice*. 2004;5(4):101-10.
31. Carvalho TS, Colon P, Ganss C, Huysmans MC, Lussi A, Schlueter N, et al. Consensus report of the European Federation of Conservative Dentistry: erosive tooth wear--diagnosis and management. *Clinical Oral Investigations*. 2015;19(7):1557-61.
32. Goga R, Chandler NP, Oginni AO. Pulp stones: a review. *International Endodontic Journal*. 2008;41(6):457-68.
33. Bernick S, Nedelman C. Effect of aging on the human pulp. *Journal of Endodontics*. 1975;1(3):88-94.
34. McCabe PS, Dummer PM. Pulp canal obliteration: an endodontic diagnosis and treatment challenge. *International Endodontic Journal*. 2012;45(2):177-97.
35. BOARD DE. Digest of Statistics 1978.
36. BOARD DE. Digest Of Statistics 1996.
37. Bakland LK, Andreasen JO. Dental traumatology: essential diagnosis and treatment planning. *Endodontic Topics*. 2004;7(1):14-34.
38. Diangelis AJ, Andreasen JO, Ebeleseder KA, Kenny DJ, Trope M, Sigurdsson A, et al. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 1. Fractures and luxations of permanent teeth. *Dental Traumatology*. 2012;28(1):2-12.
39. Palmer NO, Ahmed M, Grieveson B. An investigation of current endodontic practice and training needs in primary care in the north west of England. *British Dental Journal*. 2009;206(11):E22; discussion 584-5.
40. Chambers DW. Toward a competency-based curriculum. *Journal of Dental Education*. 1993;57(11):790-3.
41. Francis R. Robert Francis Inquiry report into Mid-Staffordshire NHS Foundation Trust. 2010.

42. General Dental Council. The First Five Years (2008 revised edition). London: GDC, 2008. Available online at <http://www.gdc-uk.org/professionals/education> (accessed March 2018).
43. General Dental Council. Preparing for Practice (2015 revised edition). London: GDC, 2015. Available online at <http://www.gdc-uk.org/professionals/education> (accessed March 2018)
44. Frank JR, Snell LS, Cate OT, Holmboe ES, Carraccio C, Swing SR, et al. Competency-based medical education: theory to practice. *Medical Teacher*. 2010;32(8):638-645.
45. Eva KW, Bordage G, Campbell C, Galbraith R, Ginsburg S, Holmboe E, et al. Towards a program of assessment for health professionals: from training into practice. *Advances in Health Sciences Education : Theory and Practice*. 2016;21(4):897-913.
46. Dawson L, Fox K. Can assessment be a barrier to successful professional development? *Physical Therapy Reviews*. 3<sup>rd</sup> ed. Taylor & Francis; 2017 June 22;21(1): 1-6.
47. Alley BS, Kitchens GG, Alley LW, Eleazer PD. A comparison of survival of teeth following endodontic treatment performed by general dentists or by specialists. *Oral surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics*. 2004;98(1):115-8.
48. Van Der Vleuten CP. The assessment of professional competence: Developments, research and practical implications. *Advances in Health Sciences Education : Theory and Practice*. 1996;1(1):41-67.
49. Epstein RM, Hundert EM. Defining and assessing professional competence. *Journal of the American Medical Association*. 2002;287(2):226-35.
50. Govaerts M, van der Vleuten CP. Validity in work-based assessment: expanding our horizons. *Medical Education*. 2013;47(12):1164-74.
51. Biggs J. Enhancing teaching through constructive alignment. *Higher Education*. 1996;32(3):347-64.
52. Dawson LJ, Mason BG, Bissell V, Youngson C. Calling for a re-evaluation of the data required to credibly demonstrate a dental student is safe and ready to practice. *European Journal of Dental Education*. 2017;21(2):130-5.
53. Fraser SW, Greenhalgh T. Coping with complexity: educating for capability. *British Medical Journal*. 2001;323(7316):799-803.
54. Butler DL, Winne PH. Feedback and Self-Regulated Learning: A Theoretical Synthesis. *Review of Educational Research*. 1995;65(3):245-81.

55. Ericsson KA. Deliberate practice and the acquisition and maintenance of expert performance in medicine and related domains. *Academic Medicine*. 2004;79(10 Suppl):S70-81.
56. Kolb, D. *Experiential learning as the science of learning and development*. Englewood Cliffs, NJ: Prentice Hall; 1984 p. 33-35.
57. Forsythe A, Johnson S. Thanks, but no-thanks for the feedback. *Assessment & Evaluation in Higher Education*. 2017;42(6):850-9.
58. Dweck CS. The development of ability conceptions. In: Wigfield A, Eccles JS, editors. *Development of achievement motivation*. San Diego (CA): Elsevier; 2002 p. 57-88.
59. Miller GE. The assessment of clinical skills/competence/performance. *Academic Medicine*. 1990;65(9 Suppl):S63-7.
60. Chambers DW. Competency-based dental education in context. *European Journal of Dental Education*. 1998;2(1):8-13.
61. Chambers DW. Dental curriculum and accreditation--means, ends, and the continuum. *Journal of Dental Education*. 1996;60(10):816-20.
62. Tekian A, Watling CJ, Roberts TE, Steinert Y, Norcini J. Qualitative and quantitative feedback in the context of competency-based education. *Medical Teacher*. 2017;39(12):1245-1249.
63. van de Ridder JM, McGaghie WC, Stokking KM, ten Cate OT. Variables that affect the process and outcome of feedback, relevant for medical training: a meta-review. *Medical Education*. 2015;49(7):658-73.
64. Hattie J, Timperley H. The Power of Feedback. *Review of Educational Research*. 2007;77(1):81-112.
65. Shute VJ. Focus on Formative Feedback. *Review of Educational Research*. 2008;78(1):153-89.
66. Kaufman DM, Mann KV. *Teaching and Learning in Medical Education: How Theory Can Inform Practice*. *Understanding Medical Education*: Wiley-Blackwell; 2010. p. 16-36.
67. Charon R. Rita Charon. *Lancet* (London, England). 2004;363(9406):404.
68. Mann K, Gordon J, MacLeod A. Reflection and reflective practice in health professions education: a systematic review. *Advances in Health Sciences Education : Theory and Practice*. 2009;14(4):595-621.
69. Murdoch-Eaton D, Sandars J. Reflection: moving from a mandatory ritual to meaningful professional development. *Archives of Disease in Childhood*. 2014;99(3):279-83.



70. Panadero E. A Review of Self-regulated Learning: Six Models and Four Directions for Research. *Frontiers in Psychology*. 2017 eCollection. [Available on <http://www.frontiersin.org/articles/10.3389/fpsyg.2017.00422/full>] Last access March 2018.
71. Bloom BS. *Taxonomy of Educational Objectives: The classification of educational goals*. New York: Longmans, Green. 6<sup>th</sup> ed 1956 .
72. Tan LT, McAleer JJ. The introduction of single best answer questions as a test of knowledge in the final examination for the fellowship of the Royal College of Radiologists in Clinical Oncology. *Clinical Oncology*. 2008;20(8):571-6.
73. Hift RJ. Should essays and other “open-ended”-type questions retain a place in written summative assessment in clinical medicine? *BMC Medical Education*. 2014;14:249.
74. Tickle M, Milsom K, Qualtrough A, Blinkhorn F, Aggarwal VR. The failure rate of NHS funded molar endodontic treatment delivered in general dental practice. *British Dental Journal*. 2008;204(5):E8; discussion 254-5.
75. Bjorndal L, Reit C. The annual frequency of root fillings, tooth extractions and pulp-related procedures in Danish adults during 1977-2003. *International Endodontic Journal*. 2004;37(11):782-8.
76. Skudutyte-Rysstad R, Eriksen HM. Endodontic status amongst 35-year-old Oslo citizens and changes over a 30-year period. *International Endodontic Journal*. 2006;39(8):637-42.
77. Mazurat R, Schonwetter DJ. Electronic curriculum mapping: supporting competency-based dental education. *Journal of the Canadian Dental Association*. 2008;74(10):886-9.
78. Norcini JJ, Swanson DB, Grosso LJ, Webster GD. Reliability, validity and efficiency of multiple choice question and patient management problem item formats in assessment of clinical competence. *Medical Education*. 1985;19(3):238-47.
79. General Dental Council. *Curriculum For Specialist Training in Endodontics* (2010 edition). London: GDC, 2010. Available online at <http://www.gdc-uk.org/api/files/endodonticscurriculum.pdf> (accessed March 2018).
80. McHarg J, Kay EJ. Designing a dental curriculum for the twenty-first century. *British Dental Journal*. 2009;207:493.
81. Newsome P, Smales R, Yip K. Oral diagnosis and treatment planning: part 1. Introduction. *British Dental Journal*. 2012;213(1):15-9.
82. Dummer PMH. Comparison of undergraduate endodontic teaching programmes in the United Kingdom and in some dental schools in Europe and the United States. *International Endodontic Journal*. 1991;24(4):169-77.

83. Qualtrough AJ, Dummer PM. Undergraduate endodontic teaching in the United Kingdom: an update. *International Endodontic Journal*. 1997;30(4):234-9.
84. Brookman DJ. Vocational trainees' views of their undergraduate endodontic training and their vocational training experience. *International Endodontic Journal*. 1991;24(4):178-186.
85. Chambers D. Learning curves: what do dental students learn from repeated practice of clinical procedures? *Journal of Dental Education*. 2012;76(3):291-302.
86. Van Der Vleuten CPM. The assessment of professional competence: Developments, research and practical implications. *Advances in Health Sciences Education*. 1996;1(1):41-67.
87. Peters MAK, Ro T, Lau H. Who's afraid of response bias? *Neuroscience of Consciousness*. 2016;2016(1).
88. Tanalp J, Güven EP, Oktay I. Evaluation of dental students' perception and self-confidence levels regarding endodontic treatment. *European Journal of Dentistry*. 2013;7(2):218-24.
89. Cunliffe J, Grey N. Crown lengthening surgery--indications and techniques. *Dental Update*. 2008;35(1):29-30, 2, 4-5.
90. West JD. The endodontic Glidepath: "Secret to rotary safety". *Dentistry Today*. 2010;29(9):86, 8, 90-3.
91. Perry S, Bridges SM, Burrow MF. A review of the use of simulation in dental education. *Simulation in Healthcare*. 2015;10(1):31-7.
92. Suvinen TI, Messer LB, Franco E. Clinical simulation in teaching preclinical dentistry. *European Journal of Dental Education*. 1998;2(1):25-32.
93. Ottestad E, Boulet JR, Lighthall GK. Evaluating the management of septic shock using patient simulation. *Critical Care Medicine*. 2007;35(3):769-75.
94. Okuda Y, Bryson EO, DeMaria S, Jr., Jacobson L, Quinones J, Shen B, et al. The utility of simulation in medical education: what is the evidence? *The Mount Sinai Journal of Medicine, New York*. 2009;76(4):330-43.
95. Albino JE, Young SK, Neumann LM, Kramer GA, Andrieu SC, Henson L, et al. Assessing dental students' competence: best practice recommendations in the performance assessment literature and investigation of current practices in predoctoral dental education. *Journal of Dental Education*. 2008;72(12):1405-35.
96. Manakil J. Reviewing Competency in Dental Education. *International Journal of Dental Clinics* 2011(3(2)):33-9.

97. Harden RM, Stevenson M, Downie WW, Wilson GM. Assessment of clinical competence using objective structured examination. *British Medical Journal*. 1975;1(5955):447-51.
98. Sloan DA, Donnelly MB, Schwartz RW, Felts JL, Blue AV, Strodel WE. The Use of the Objective Structured Clinical Examination (OSCE) for Evaluation and Instruction in Graduate Medical Education. *Journal of Surgical Research*. 1996;63(1):225-30.
99. Schoonheim-Klein ME, Habets LL, Aartman IH, van der Vleuten CP, Hoogstraten J, van der Velden U. Implementing an Objective Structured Clinical Examination (OSCE) in dental education: effects on students' learning strategies. *European Journal of Dental Education*. 2006;10(4):226-35.
100. Boursicot K, Etheridge L, Setna Z, Sturrock A, Ker J, Smee S, et al. Performance in assessment: consensus statement and recommendations from the Ottawa conference. *Medical Teacher*. 2011;33(5):370-83.
101. Setyonugroho W, Kennedy KM, Kropmans TJ. Reliability and validity of OSCE checklists used to assess the communication skills of undergraduate medical students: A systematic review. *Patient Education and Counselling*. 2015; 98(12):1482-1491.
102. McCambridge J, Witton J, Elbourne DR. Systematic review of the Hawthorne effect: new concepts are needed to study research participation effects. *Journal of Clinical Epidemiology*. 2014;67(3):267-77.
103. Hodges BD. Sea monsters & whirlpools: Navigating between examination and reflection in medical education. *Medical Teacher*. 2015;37(3):261-6.
104. Chambers DW, Geissberger M. Toward a competency analysis of operative dentistry technique skills. *Journal of Dental Education*. 1997;61(10):795-803.
105. <https://www.rcseng.ac.uk/-/media/files/rcs/fds/publications/curricula/endo.pdf?la=en>. Royal College of Surgeons, Edinburgh [Accessed March 2018]
106. Badsar A, Taramsari MR, Hoseinpour J, Jahromi SK. Postgraduate trainees' perception of the clinical learning environment at an Iranian Medical Sciences University. *Procedia - Social and Behavioral Sciences*. 2012;46(Supplement C):1084-90.
107. Seabrook MA. Clinical students' initial reports of the educational climate in a single medical school. *Medical Education*. 2004;38(6):659-69.
108. Miles S, Swift L, Leinster SJ. The Dundee Ready Education Environment Measure (DREEM): A review of its adoption and use. *Medical Teacher*. 2012;34(9):e620-e34.
109. Abraham R, Ramnarayan K, Vinod P, Torke S. Students' perceptions of learning environment in an Indian medical school. *BMC Medical Education*. 2008;8(1):20.

110. Jiffry MTM, McAleer S, Fernando S, Marasinghe RB. Using the DREEM questionnaire to gather baseline information on an evolving medical school in Sri Lanka. *Medical Teacher*. 2005;27(4):348-52.
111. Roff S, McAleer S, Ifere OS, Bhattacharya S. A global diagnostic tool for measuring educational environment: comparing Nigeria and Nepal. *Medical Teacher*. 2001;23(4):378-82.
112. Roff S, McAleer S, Harden RM, Al-Qahtani M, Ahmed AU, Deza H, et al. Development and validation of the Dundee Ready Education Environment Measure (DREEM). *Medical Teacher*. 1997;19(4):295-9.
113. Roff S, McAleer S, Skinner A. Development and validation of an instrument to measure the postgraduate clinical learning and teaching educational environment for hospital-based junior doctors in the UK. *Medical Teacher*. 2005;27(4):326-31.
114. Ousey K, Stephenson J, Brown T, Garside J. Investigating perceptions of the academic educational environment across six undergraduate health care courses in the United Kingdom. *Nurse Education in Practice*. 2014;14(1):24-9.
115. Al-Kabbaa AF, Ahmad HH, Saeed AA, Abdalla AM, Mustafa AA. Perception of the learning environment by students in a new medical school in Saudi Arabia: Areas of concern. *Journal of Taibah University Medical Sciences*. 2012;7(2):69-75.
116. Mason M. Sample Size and Saturation in PhD Studies Using Qualitative Interviews. 2010. 2010;11(3).
117. Ajzen I. The theory of planned behavior. *Organizational Behavior and Human Decision Processes*. 1991;50(2):179-211.
118. Dawson L. Developing and assessing professional competence: using technology in learning design. *For the Love of Learning - Innovations from Outstanding University Teachers*. 2013(19).
119. Fush PI. Are We There Yet? Data saturation in qualitative research. *The Qualitative Report*. 2015;20(9):1408-16.
120. Kern D. Curriculum development for medical education: A six-step approach. John Hopkins University Press. 1998.
121. Kersten HW. The enhancement of learning by teaching. *European Journal of Dental Education*. 1997;1(4):149-52.
122. Mousavi SH, Monfared SY, Heidary A. Investigating The relationship between life quality and productivity in physical education office employees in Zanjan province. *Procedia - Social and Behavioral Sciences*. 2011;15:3665-8.

123. Lazarus. Psychological stress and the coping process. New York, NY 1966.
124. World Health Report 2013: Research for universal health coverage 2013 [Available from: <http://www.who.int/whr/en/>]. Accessed March 2018.
125. Windle G. What is resilience? A review and concept analysis. *Reviews in Clinical Gerontology*. 2010;21(2):152-69.
126. Earvolino-Ramirez M. Resilience: a concept analysis. *Nursing Forum*. 2007;42(2):73-82.
127. Leppin AL, Bora PR, Tilburt JC, Gionfriddo MR, Zeballos-Palacios C, Dulohery MM, et al. The efficacy of resiliency training programs: A systematic review and meta-analysis of randomized trials. *PloS one*. 2014;9(10):e111420.
128. Pereira EAC, Dean BJF. British surgeons' experiences of mandatory online workplace-based assessment. *Journal of the Royal Society of Medicine*. 2009;102(7):287-93.
129. Munsch C. British surgeons' experiences of mandatory online workplace-based assessment – reply to authors. *Journal of the Royal Society of Medicine*. 2009;102(9):357-8.
130. Leung WC. Competency based medical training: review. *British Medical Journal*. 2002;325(7366):693-6.
131. Pereira EA, Dean BJ. British surgeons' experiences of a mandatory online workplace based assessment portfolio resurveyed three years on. *Journal of Surgical Education*. 2013;70(1):59-67.
132. Grieveson B, Kirton JA, Palmer NO, Balmer MC. Evaluation of workplace based assessment tools in dental foundation training. *British Dental Journal*. 2011;211(4):E8.
133. Burgess A, McGregor D, Mellis C. Medical students as peer tutors: a systematic review. *BMC Medical Education*. 2014;14:115-.
134. Topping KJ. The effectiveness of peer tutoring in further and higher education: a typology and review of the literature. *Higher Education*. 1996;32(3):321-45.
135. Ten Cate O, Durning S. Peer teaching in medical education: twelve reasons to move from theory to practice. *Medical Teacher*. 2007;29(6):591-9.
136. Carr SE, Brand G, Wei L, Wright H, Nicol P, Metcalfe H, et al. "Helping someone with a skill sharpens it in your own mind": a mixed method study exploring health professions students experiences of Peer Assisted Learning (PAL). *BMC Med Educ*. 2016;16.
137. Bush HM, Schreiber RS, Oliver SJ. Failing to fail: clinicians' experience of assessing underperforming dental students. *European Journal of Dental Education*. 2013;17(4):198-207.

138. Herrmann-Werner A, Gramer R, Erschens R, Nikendei C, Wosnik A, Griewatz J, et al. Peer-assisted learning (PAL) in undergraduate medical education: An overview. *Zeitschrift für Evidenz, Fortbildung und Qualität im Gesundheitswesen*. 2017;121:74-81. (English abstract).
139. van der Vleuten CP, Schuwirth LW. Assessing professional competence: from methods to programmes. *Medical Education*. 2005;39(3):309-17.
140. Wilkinson JR, Crossley JG, Wragg A, Mills P, Cowan G, Wade W. Implementing workplace-based assessment across the medical specialties in the United Kingdom. *Medical Education*. 2008;42(4):364-73.
141. Dawson LJ. 'But Professor, you no longer take exams...so how do you learn?' : Maastricht University [Available from: [https://www.maastrichtuniversity.nl/news-events/newsletters/article/1Ar174KpE\\_O+7iVggf5Uw](https://www.maastrichtuniversity.nl/news-events/newsletters/article/1Ar174KpE_O+7iVggf5Uw). Last accessed March 2018.
142. Sim J, Radloff A. Enhancing reflective practice through online learning: impact on clinical practice. *Biomedical Imaging and Intervention Journal*. 2008;4(1) e8.
143. Bandura A. Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist*. 1993;28(2):117-48.
144. Polyzois I, Claffey N, Mattheos N. Problem-based learning in academic health education. A systematic literature review. *European Journal of Dental Education*. 2010;14(1):55-64.
145. Onyon C. Problem-based learning: a review of the educational and psychological theory. *The Clinical Teacher*. 2012;9(1):22-6.
146. Bassir SH, Sadr-Eshkevari P, Amirikhorheh S, Karimbux NY. Problem-based learning in dental education: a systematic review of the literature. *Journal of Dental Education*. 2014;78(1):98-109.
147. Miller A, Archer J. Impact of workplace based assessment on doctors' education and performance: a systematic review. *British Medical Journal*. 2010;341:c5064.
148. Boyce P, Spratt C, Davies M, McEvoy P. Using entrustable professional activities to guide curriculum development in psychiatry training. *BMC Med Educ*. 2011;11(96) p. 1-8.
149. Frank JR, Danoff D. The CanMEDS initiative: implementing an outcomes-based framework of physician competencies. *Medical Teacher*. 2007;29(7):642-7.
150. Mulder H, Ten Cate O, Daalder R, Berkvens J. Building a competency-based workplace curriculum around entrustable professional activities: The case of physician assistant training. *Medical Teacher*. 2010;32(10):e453-9.

151. Berberat PO, Harendza S, Kadmon M. Entrustable Professional Activities – visualization of competencies in postgraduate training. Position paper of the Committee on Postgraduate Medical Training of the German Society for Medical Education (GMA). GMS Zeitschrift für Medizinische Ausbildung. 2013;30(4). (English abstract.)
152. James JT. A new, evidence-based estimate of patient harms associated with hospital care. Journal of Patient Safety. 2013;9(3):122-8.

## Appendix 1 – The Full Curriculum Map

	A
1	<b>GDC Curriculum for specialist training in endodontics - June 2010</b>
2	<b>EXAMINATION AND DIAGNOSIS</b>
3	Complete a thorough examination of the patients;
4	Oral mucosa and related structures, periodontium, dental hard tissues
5	make appropriate diagnoses
6	Take into account any systemic factors likely to have a bearing on the above
7	Complete a thorough examination on any existing prosthesis (and related tissues)
8	Be able to evaluate the biological and aesthetic quality of the prosthesis
9	Use all appropriate investigations to diagnose oral problems
10	e.g. radiographs. Sensibility, haematological, microbiology tests & articulated study casts
11	<b>DEVELOPMENT OF Rx STRATEGIES AND PLANS IN ENDODONTICS</b>
12	weigh options against each other and succinctly describe pros and cons of each
13	communicate the facts in terms of appropriate to the intellectual capacity of the patient
14	Communicate clearly/succinctly the impact of oral status, proposed Rx and QoL to the patient
15	Advise on the possible and probable outcomes of the Rx options
16	As well as the need for future supportive care, prevention and maintenance
17	Discuss the impact on proposed Rx of constraints of political / financial systems
18	Delineate strategies/plans according to skills of other clinicians involved in the care of the pt
19	Explain, motivate, engage, assure and assess the pts participation and compliance in their own oral care
20	<b>HEALTH PROMOTION &amp; PREVENTION OF DISEASES INCLUDING INFECTION CONTROL</b>
21	Communicate in lay terms appropriate to the the intellectual capacity of the pt
22	Communicate with pts on the impact of their oral status and the proposed advice on the QoL
23	Advice on the possible outcomes of non compliance
24	The need for supportive care, prevention and maintenance
25	Use appropriate methods and technologies to prevent infection during Rx, between pts and staff and any transport between lab / clinic
26	Use appropriate knowledge and clinical techniques to diagnose related clinical problems from first principles
27	Manage combined perio endo lesions
28	Co-ordinate the management of patients requiring endo and/or pros Rx before, during and after perio Rx
29	Demonstrate Rx planning and management skills in dealing with medically compromised / Special needs pts
30	Demonstrate Rx planning and Mx skills in assessing teeth for RCT + restoration OR extraction / implant replacement
31	Demonstrate Rx planning and practical skills necessary for restoring endo Rx teeth using a range of techniques
32	Apply knowledge of occlusion in the assessment / Mx of endodontically involved teeth
33	Demonstrate ability to assess when input of specialist colleague is required in planning / execution of integrated care
34	Communicate clear Rx plans to colleagues including other dental specialists, GDP's, DCP's where appropriate
35	<b>PULP THERAPY</b>
36	Judge when vital pulp therapies are indicated
37	Execute the various clinical procedures with efficiency and skills
38	Communicate effectively with pts (parents/carers), and clinical colleagues in the need for post op monitoring
39	Assess the outcome of vital pulp therapy
40	Assess the need for further intervention in the face of an uncertain outcome



	A
41	<b>NON-SURGICAL ROOT CANAL TREATMENT</b>
42	Demonstrate proficiency in general patient management
43	Organise and Mx the working environment and schedule
44	Demonstrate proficiency in controlled manipulation of hand / automated instruments and materials
45	Assess the restorative needs of the remaining tooth tissue
46	Design / execute appropriate foundational restorations to safeguard coronal seal, tooth protection, occlusal stability, aesthetics
47	Communicate clearly and effectively with clinical colleagues and pts on matters of prognosis, appropriate restoration, supportive care and
48	<b>NON-SURGICAL ROOT CANAL RETREATMENT</b>
49	Show specialist level skills in the planning of non-surgical reRCT
50	Inform pt of the risks & limitations of procedures for coronal disassembly and non-surgical re RCT
51	Communicate clearly and effectively with pts emerging issues during retreatment (perforation, untreatable fracture etc)
52	Demonstrate proficiency in the application of materials, instruments and techniques for Mx post-Rx disease
53	Exercise decisive and sound judgement in the face of unfavourable findings / setbacks (deciding to abort treatment)
54	<b>SURGICAL ROOT CANAL TREATMENT</b>
55	Specialist level skill in the planning of investigative and corrective surgery
56	Exhibit specialist-level refinement in surgical hard and soft-tissue Mx
57	Appropriately select and manipulate materials, instruments and techniques for all stages of investigative and corrective surgery
58	Mx all aspects of peri-operative care for patients undergoing surgical RCT
59	Exchange clearly and appropriately laboratories handling biopsy specimens
60	<b>DENTAL TRAUMATOLOGY</b>
61	Demonstrate specialist-level efficiency and confidence in the Mx of dental trauma
62	Undertake procedures to facilitate primary wound healing following trauma
63	Mx the psychological and physical well-being of the pt and accompanying person during acute trauma Mx and follow up
64	Communicate clearly and effectively on the patterns of tissue reaction and consequences following trauma

	A
65	<b>PAIN CONTROL AND MANAGEMENT (ACUTE &amp; CHRONIC), ANALGESIA, SEDATION AND ANAESTHESIA</b>
66	Confidently and efficiently assess pts presenting with painful conditions
67	Appropriately Mx the use of all standard local anaesthetic and analgesic regimes
68	Identify patients requiring specialist or interdisciplinary care for the Mx of non-dental and chronic pain conditions
69	<b>MANAGEMENT AND ADMINISTRATION</b>
70	Utilise appropriate communication / presentation / negotiation / counselling / appraisal / mentoring skills
71	Communicate effectively and empathically with colleagues at all levels
72	Utilise appropriate negotiating and listening skills to achieve the desired result
73	Treat pts, carers, colleagues fairly and in line with the law and promote equal opportunities
74	Handle complaints sympathetically and efficiently
75	Mx time and delegates as appropriate
76	Use appropriate computer hardware / software to facilitate admin and clinical practice
77	<b>CLINICAL GOVERNANCE</b>
78	Utilise appropriate communication / presentation skills
79	Show the necessary skills of self-reflection/appraisal used to identify continuing professional development needs
80	Utilise critical appraisal skills and be able to apply in research evidence
81	Organise and undertake clinical audit project including implementation of outcomes and re-audit
82	Produce and update patient information material
83	Construct, analyse and use patient surveys
84	Use procedures to ensure consumer involvement and consultation
85	<b>TEACHING AND COMMUNICATION</b>
86	Utilise appropriate communication / presentation skills
87	<b>CLINICAL IMAGING</b>
88	Interpret radiographic images and write an accurate radiographic report
89	Produce a standard set of photographs illustrating progress through a course of Rx
90	<b>RESEARCH</b>
91	Produce written reports / articles, including preparing and altering manuscripts, where appropriate, under supervision
92	Present research work to professional colleagues or at specialists' meetings

	B
1	<b>GDC Preparing for Practice - 2015</b>
2	
3	Undertake an appropriate systematic intra and extra-oral examination (1.2.2)
4	Assess, manage periodontal & soft tissues (1.11.1). Describe to pt. impact of periodontal health on overall Tx plan outcomes (1.11.2)
5	Formulate a differential diagnosis / diagnoses and from there a definitive diagnosis (1.4.2)
6	Identify general and systemic disease and explain their relevance to oral health and their impact on clinical treatment (1.1.4)
7	
8	
9	Undertake relevant special investigations and diagnostic procedures
10	including radiographs (1.2.4)
11	
12	Formulate an appropriate treatment plan, synthesising patient assessment and diagnosis data (1.5.1)
13	Explain the principles of obtaining valid patient consent (1.5.3) & Obtain consent (1.5.4)
14	Identify, explain and Mx the impact of medical & psychological conditions in the pt (1.7.2)
15	Monitor and review Rx outcomes (1.7.3)
16	
17	
18	Refer patients for treatment or advice when and where appropriate (1.5.5)
19	
20	
21	
22	
23	
24	
25	Implement, perform and Mx effective decontamination and infection control procedures (1.8.2)
26	
27	
28	
29	Identify, explain and manage the impact of medical and psychological conditions in the patient
30	
31	Mx restorative procedures that preserve tooth structure, replace missing or defective tooth structure, ...(1.14.5)
32	Asses and manage caries, occlusion, and tooth wear (1.14.1)
33	
34	Identify and explain when and how to refer patients for specialist treatment and apply to practice (1.13.5)
35	
36	Assess, diagnose and Mx the health of the dental pulp and periradicular tissues
37	Including Rx to prevent pulp and periradicular disease (1.14.6)
38	
39	
40	

	B
41	
42	Evaluate the need for more complex Rx and refer accordingly (1.14.10)
43	
44	Determine the prognosis of appropriate non surgical Tx to manage pulpal and peri-radicular disease in uncomplicated ... (1.14.8)
45	
46	
47	Determine the prognosis of appropriate non surgical Tx to manage pulpal and peri-radicular disease in uncomplicated... (1.14.8)
48	
49	
50	Recognise the risks of non-surgical root canal treatment and how to manage them (1.14.9)
51	
52	
53	
54	
55	Recognise the role of surgical Mx of periradicular disease (1.14.7)
56	
57	
58	
59	Manage appropriate clinical and laboratory investigations (1.2.3)
60	
61	Recognise and manage dento-alveolar and mucosal trauma (1.9.3)
62	
63	Prevent, diagnose and manage patient anxiety appropriately, effectively and safely (1.7.4)
64	Identify the need for and make arrangements for follow-up care (1.9.4)

	B
65	
66	Recognise and Mx pts acute oro-facial and dental pain (1.9.1)
67	Prevent, diagnose and manage pain appropriately, effectively and safely (1.7.5)
68	Explain the role and organisation of referral networks, clinical guidelines and policies and local variation (1.7.9)
69	
70	Explain, evaluate, and apply to clinical practice psychological and sociological concepts and theoretical frameworks...(1.1.13)
71	Explain the need to take responsibility for establishing personal networks with local dental and medical colleagues... (1.7.10)
72	(3.1) includes pts with anxiety, breaking bad news, discussing alcohol / smoking
73	Treat all patients with equality, respect and dignity (1.7.1)
74	
75	
76	
77	
78	
79	
80	Critically appraise approaches to dental research and integrate with patient care (1.1.2)
81	
82	Recognise and take responsibility for the quality of services and devices provided to the patient (1.8.3)
83	
84	
85	
86	
87	
88	Explain and apply scientific principles of medical ionizing radiation and statutory regulations (1.1.11)
89	
90	
91	
92	

## Appendix 2 – The Survey

**Clinical Endodontics** (not the final Dental Professional Examination – this will be covered in Phase 3)

**1. Student numbers:** In your school, how many students are in each clinical year?

Year size	Number
How many students are in each clinical year?	
Free comments:	

**2. Timing of endodontic clinical experience:** When do your students begin to perform endodontic procedures on patients and do they continue throughout the clinical years of the course, or only during specified periods of the course?

Timing of endodontic procedures	Describe
When do your students begin to perform endodontic procedures on patients?	
Our students perform endodontic procedures throughout their clinical years	
Our students perform endodontic procedures only during defined periods of their clinical training	
Free comments:	

**3. Location of teaching:** Where do your students receive the majority of their clinical endodontic teaching?

Location of clinical endodontic teaching	X all that apply
Dedicated endodontic clinics within the Dental School	
Mixed 'Conservation' or 'Restorative' clinic within the Dental School	
Community clinics outside the Dental School	
Free comments:	

**4. Nature of teachers:** Who teaches and assesses your students in clinical endodontics?

Profile of teachers	X all that apply
Only teachers who specialise in endodontics (we recognise that not all countries formally recognise 'specialists' in endodontics)	
Only general practitioners	
A combination of general practitioners and those who specialise in endodontics	
Free comments:	

**5. Staff:student ratios:** What is the usual staff:student ratio in the clinics where your students perform endodontic procedures?

Staff:student ratio	Number
What is the typical staff:student ratio in the clinics where your students perform endodontic procedures?	
Free comments:	

**6. Levels of activity:** Do you have specific requirements for the NUMBER of cases your students must perform during their clinical attachments?

Rules on numbers of cases	X all that apply
Yes (if yes, please provide more details below)	
No	
Please provide additional details:	

**7. Essential experience:** Is it possible for a student to leave your dental school without having completed certain endodontic procedures?

Experience	X all that apply
It is possible for a student in my school to gain NO experience of indirect pulp capping	
It is possible for a student in my school to gain NO experience of direct pulp capping	
It is possible for a student in my school to gain NO experience of Cvek, partial pulpotomy on permanent teeth	
It is possible for a student in my school to gain NO experience of full pulp chamber pulpotomy on permanent teeth	
It is possible for a student in my school to gain NO experience of root canal treatment	
It is possible for a student in my school to gain NO experience of molar root canal treatment	
It is possible for a student in my school to gain NO experience of root canal re-treatment	
It is possible for a student in my school to gain NO experience of conducting an apexification procedure.	
It is possible for a student in my school to gain NO experience of conducting a perforation repair.	
Free comments:	

**8. Patient supply:** Are you concerned that you may not be able to provide sufficient numbers of uncomplicated clinical cases for your students to treat?

Supply of suitable cases	X all that apply
I am concerned about the limited supply of suitable cases	
I am NOT concerned about the limited supply of suitable cases	
Free comments:	

**9. Formal testing:** Do you formally test your students on their endodontic skills and knowledge during their clinical years? (Note: the final professional examination will be considered in the next phase of this work, so do not include that here)

Formal testing	X all that apply
Yes, we formally test students on their endodontic knowledge	
Yes, we formally test students on their endodontic skills	
Please provide details:	

**10. Continuous assessment:** Do you have a system for grading and providing feedback on the clinical activity of your students, in terms of knowledge, skills and professionalism, and is there a process in your school for reviewing performance at intervals during the clinical years?

Continuous assessment	X all that apply
Yes, we have a paper-based system to grade and provide feedback to our students as they conduct endodontic procedures in the clinics	
Yes, we have an electronic system to grade and provide feedback to our students as they conduct endodontic procedures in the clinics	
Yes, we have a process to review the progress of our students at intervals during the clinical years	
Free comments:	

**11. Reflection:** Do you encourage reflection?

Reflection	X all that apply
Yes, we encourage our students to reflect on their clinical activity	
Please provide details:	

**11. Remediation:** How do you manage students who lack sufficient experience/competence during the clinical years?

Remediation	X all that apply
What is your approach in case you determine students with lack of sufficient competency? Is there a special program to enhance the skills of these students?	
Please provide details:	

**12. Sharing materials:** Would your School be willing and able to share any of the materials they use in monitoring and assessing students in clinical endodontics?

Sharing materials	X all that apply
Yes, we would be willing and able to share materials relevant to our monitoring and assessment of students in clinical endodontics	
Please provide details:	

**13. Further free comments:**

Please provide any further free comments:
---

**End of the questionnaire. Thank you for your time and trouble in sharing these valuable insights.**

## Appendix 3 – Ethical Approval



### School of Medicine

Faculty of Health and Life Sciences  
Cedar House  
Ashton Street  
Liverpool  
L69 3GE

T: 0151 795 4358  
F: 0151 794 8763  
W: [www.liv.ac.uk](http://www.liv.ac.uk)

14<sup>th</sup> March 2017

Dear Dr Alansari

I am pleased to say we are able to approve the request for ethical approval to undertake your research project. Details of the approval can be found below:

Ref:	201608190
PI/Supervisor:	Dr Abdulwahab Alansari
Title:	Trialling a Novel Approach to Monitor and Assess Endodontic Postgraduate Training (Adjusting the current undergraduate software to suit postgraduate educational needs and trialling it on current postgraduate DDSc endodontic candidates)
First Reviewer:	Dr Jayne Garner
Second Reviewer:	Dr Chris Huntley
Date of Approval:	14 <sup>th</sup> March 2017

The application was APPROVED subject to the following conditions:

### Conditions

- 1 All serious adverse events must be reported to the Sub-Committee within 24 hours of their occurrence, via the Research Governance Officer ([ethics@liv.ac.uk](mailto:ethics@liv.ac.uk)).
- 2 This approval applies for the duration of the research. If it is proposed to extend the duration of the study as specified in the application form, IPHS REC should be notified as follows. If it is proposed to make an amendment to the research, you should notify IPHS REC by following the Notice of Amendment procedure outlined at <http://www.liv.ac.uk/researchethics/amendment%20procedure%209-08.doc>
- 3 If the named PI / Supervisor leaves the employment of the University during the course of this approval, the approval will lapse. Therefore please contact the Institute's Research Ethics Office at [iphsrec@liverpool.ac.uk](mailto:iphsrec@liverpool.ac.uk) in order to notify them of a change in PI/Supervisor.

Best wishes and good luck with the study.

*D Prescott*

Miss Debbie Prescott

ILT Ethics Review Group (Staff) Secretary

E: [prescot@liverpool.ac.uk](mailto:prescot@liverpool.ac.uk)

T: 0151 795 4358



## Appendix 4 – The Interview Schedule

1. **Are you aware of any guidelines or curricula for postgraduate endodontic specialist training?**

Potential Answers:

No / Yes / 'I know the guidelines by RCS / ESE' - what do you think of them? are the guidelines all inclusive? do they reflect what you think an endodontist should know? Are you aware of the curriculum published by the GDC?

2. **Do you feel the current learning and assessment structure of the DDSc program is adequately preparing you to be an expert in the field of endodontics?**

Potential Answers:

- Yes / No .... if no...why? elaborate? which aspect exactly? research / clinical? Range of cases vs. seminars vs. hands on clinical teaching etc.

ISCP WBA's

3. **What is your opinion on the use of WBA's in postgrad specialist training in endodontics?**

What are the positives / negatives? Elaborate on current use, and what you would change if you can... why would you change? If candidate is happy with current use then enquire why its helpful and what in particular is helpful...

4. **Have you developed any tactics to aid in your progress through WBA's?**

Think about using 'strategies' instead of 'tactics'...?? Annual progression instead of assessment process / or passing the course...or hitting targets....?

Consider what tactics they are, have the current tactics evolved from a different tactic used when going through undergraduate training? How different do you think your progress would be without those tactics? Do you feel the tactics help your development and help you throughout the education and training process?

LIFTUPP

5. **How do you feel about the use of LIFTUPP for undergraduate endo training?**

Current use, what you would change, strategies and tactics

6. **Do you think LIFTUPP could have a role in postgraduate endodontic training?**

Potential Answers:

Good / Poor...why? what would you change? why do you think that change will be useful? Similar probing to WBA's subquestions

7. **Excluding any issues discussed previously, do you feel any other aspect of the specialist endodontic training process should be maintained as is....or changed/ removed all together?**

Probe further on research, audits, other expectations throughout the course that were not covered by WBA's/LIFTUPP..how much weight does that carry in comparison to WBA's and clinical aspects of the course.



## Appendix 5 – Participant Information Leaflet



### Information sheet

#### **Trialling a Novel Approach to Monitor and Assess Endodontic Postgraduate Training**

**You are being invited to participate in a research study. Before you decide whether to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and feel free to ask us if you would like more information or if there is anything that you do not understand. Please also feel free to discuss this with your friends, relatives and GP if you wish. We would like to stress that you do not have to accept this invitation and should only agree to take part if you want to.**

#### **Purpose of the study**

The study seeks to identify your own training experiences and thoughts on the DDSc program thus far by carrying out a project that supports enhancement of learning and teaching in your institution. We are interested to know more about how you are developing as a specialist in training, taking into account requirements of the governing bodies. In addition, we would like to know more about your current use of LIFTUPP in both undergraduate and postgraduate endodontics at LUDH, combined with work-based assessments. The recruited interviewees will consist of (up to) 7 postgraduates undergoing the DDSc in Endodontics programme i.e. the entire cohort if possible.

Participation is voluntary and participants are free to withdraw at anytime without explanation and without incurring a disadvantage.

As this is a new programme it is important to know more of the experiences and insights of those who took part in the programme as this will help us to identify key underpinning factors and to better inform the current LIFTUPP used in postgraduate training.

#### **Time commitment**

You are requested to take part in a semi-structured face to face interview. The interviews will last between a half and one hour. If you agree, the interview will be audio recorded. We will also check with you that we have transcribed and understood your views correctly.

#### **Confidentiality**

The interviews will be transcribed by a professional transcriber. The transcripts will be securely stored on the University's system, on a University HP laptop which will be used to store audio files, and used by the transcriber to type and save the scripts. We will send you a copy of the transcription and a draft of the initial report of the study. The transcriptions will undergo thematic analysis. Your personal details will not be identified in any publication either within the University or more widely unless you explicitly give permission. You are free to withdraw at any time and have any data returned to you. There are no known risks within the realms of this study, however should the participant experience any discomfort or disadvantage as part of the interview process, they should inform the researcher immediately.

*If you are unhappy, or if there is a problem, please feel free to let us know by contacting Abdulwahab Alansari ([wahab@liv.ac.uk](mailto:wahab@liv.ac.uk)) and we will try to help. If you remain unhappy or have a complaint which you feel you cannot come to us with then you should contact the Research Governance Officer at [ethics@liv.ac.uk](mailto:ethics@liv.ac.uk). When contacting the Research Governance Officer, please provide details of the name or description of the study (so that it can be identified), the researcher(s) involved, and the details of the complaint you wish to make.*

**Thank you**  
Dr Abdulwahab Alansari  
PG DDSc Endodontics  
University of Liverpool  
June 2016 - Version 3

## Appendix 6 – Participant Consent Form



### CONSENT FORM

#### Trialling a Novel Approach To Monitor and Assess Endodontic Postgraduate Training

Primary researcher: Dr Abdulwahab Alansari  
Supervisors: Professor Luke Dawson and Dr Fadi Jarad

**Please  
initial box**

1. I confirm that I have read and have understood the information sheet dated JUNE / JULY for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my rights being affected. In addition I am free to refuse to answer any question without obligation to provide an explanation.
3. I understand and agree that my participation will be audio recorded and I am aware of and consent to your use of these recordings for the following purposes (transcription, thematic analysis, DDS project write up, potential journal publication)
4. I understand that, under the Data Protection Act, I can at any time ask for access to the information I provide and I can also request the destruction of that information if I wish.
5. I agree to take part in the above study.

_____ Participant Name	_____ Date	_____ Signature
_____ Name of Person taking consent	_____ Date	_____ Signature
_____ Researcher	_____ Date	_____ Signature

**The contact details of lead Researcher (Principal Investigator) are:**

DrAbdulwahab Alansari  
Postgraduate Office - 3rd Floor  
Dental Hospital - Pembroke Place  
Liverpool L3 5PS

Tel: 0151 706 5240  
Email: [wahab@liverpool.ac.uk](mailto:wahab@liverpool.ac.uk)